The design, development, and evaluation of Lifelab Dublin; an interactive and engaging health literacy experience for adolescents from socioeconomically disadvantaged populations

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Authors Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of Doctor of Philosophy is entirely my own work, and that I have exercised reasonable care to ensure that the work is original, and does not to the best of my knowledge breach any law of copyright, and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

Signed: Craig Smith **ID no:** 14733645 **Date:** 16/08/2023

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Table of Contents

List of Tables

List of Figures

List of Abbreviations

ACC = Adolescent Challenge Creator

BMI = Body Mass Index

BREQ = Behaviour Regulation for Exercise Questionnaire

DCU = Dublin City University

DEIS = Delivery Equality of Opportunities in Schools

HL = Health Literacy

HLQ = Health Literacy Questionnaire

HLS-EU-Q = European Health Literacy Survey Questionnaire

HLSAC = Health Literacy for School-Aged Children

HPS = Health Promoting Schools

MM = mixed Methods

MRC = Medical Research Council

MVPA = Moderate to Vigorous Physical Activity

NCD = Non-Communicable Disease

NVS = Newest Vital Sign

Ophelia = Optimising Health Literacy

PA = Physical Activity

PBL = Problem-Based Learning

PE = Physical Education

PRISMA-P = Preferred Reporting Items For Systematic Review And Meta-Analysis Protocols

QL = Qualitative

QT = Quantitative

RCT = Randomised Controlled Trial

REALM = Rapid Estimate of Adult Literacy in Medicine

RTA = Reflexive Thematic Analysis

SDT = Self Determination Theory

SES = Socioeconomic Status

SPHE = Social, Personal and Health Education

TOFHLA = Test of Functional Health Literacy in Adults

WHO = World Health Organisation

YHF = Youth Health Forum

Abstract

PhD Title: The design, development, and evaluation of LifeLab; an interactive and engaging health literacy experience for adolescents from socioeconomically disadvantaged populations.

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Addressing adolescent's health literacy (HL) has been recognised as a strategy to empower individuals to take control of their health and promote health equity. Schools have been identified as an ideal intervention setting; however, many interventions are ineffective due to a lack of alignment with the context. The aim of this thesis was to design, develop and evaluate LifeLab: an engaging school-based HL intervention for socioeconomically disadvantaged adolescents.

Study one was a systematic review of school-based HL interventions targeting socioeconomically disadvantaged adolescents, which aimed to identify effective intervention strategies. Although the review highlighted the dearth of interventions explicitly targeting HL, 'hands-on' learning activities; the use of peer support; and holistic approaches targeting the school environment, the parents or the local community were identified as effective strategies.

Study two aimed to co-design and formatively evaluate LifeLab learning activities with, and for, low socioeconomic adolescents to inform the development of the LifeLab intervention. Co-design workshops with the adolescents provided valuable information on methods to engage young people in health education; practical considerations for implementing a HL intervention; and the health-related content that adolescents in this context feel is meaningful and important.

Study three was a process evaluation assessing the acceptability, fidelity, dose delivered, reach and effectiveness of the LifeLab intervention. The results highlighted that overall, the intervention was positively perceived, particularly the out-of-school elements. The teachers highlighted some difficulties with the school-based content, which impacted the delivery of the lessons. The reach and fidelity of LifeLab were high, but the intervention did not impact the adolescent's motivation to adopt healthier behaviours.

This PhD highlights the importance of adopting a co-design approach and has developed an evidence-base for designing engaging HL experiences for young people, which can be used to inform future versions of the LifeLab intervention, as well as other school-based health interventions.

Chapter 1: Introduction to the Thesis

Publications and communications resulting from this PhD work:

Journal articles – Published

Smith, C.; Goss, H.R; Issartel, J.; Belton, S. (2021) Health Literacy in Schools? A Systematic Review of Health-Related Interventions Aimed at Disadvantaged Adolescents. Children, 8, 176. https://doi.org/10.3390/children8030176.

Smith, C.; Goss, H.R.; Issartel, J.; Meegan, S.; Belton, S. (2022) LifeLab: Co-Design of an Interactive Health Literacy Intervention for Socioeconomically Disadvantaged Adolescents'. Children 2022, 9, 1230. https://doi.org/10.3390/children9081230

Journal articles – Under Review

Smith, C.; Goss, H.R.; Issartel, J.; Meegan, S.; Belton, S. (2022) LifeLab: A process evaluation of LifeLab; an interactive health literacy intervention for socioeconomically disadvantaged adolescents. Journal of Qualitative Studies of Health and Well-being

Associated journal articles – Published

Goss, H.R.; McDermott, C.; Hickey, L.; Issartel, J.; Meegan, S.; Morrissey, J.; Murrin, C.; Peers, C.; **Smith, C**.; Spillane, A.; et al. (2021) Understanding disadvantaged adolescents' perception of health literacy through a systematic development of peer vignettes. BMC Public Health, 21, 593. https://doi.org/10.1186/s12889-021-10634-x.

Goss, H.R.; **Smith, C.;** Hickey, L.; Issartel, J.; Morrissey, J.; Murrin, C.; Spillane, A.; Belton, S. (2022) Using Co-Design to Develop a Health Literacy Intervention with Socially Disadvantaged Adolescents. Int. J. Environ. Res. Public Health, 19, 4965. https://doi.org/10.3390/ijerph19094965.

Conference Communications

Smith, C.; Goss, H.R.; Issartel, J.; Belton, S. (2021) Health Literacy in Schools? A Systematic Review of Health-Related Interventions Aimed at Disadvantaged Adolescents. Global Health Literacy summit. (e-Poster)

Smith, C.; Goss, H.R.; Hickey, L.; Issartel, J.; Morrissey, J.; Murrin, C.; Spillane, A.; Belton, S. (2021) The Co-Design of an Interactive and Engaging Health Literacy Lab Experience. UK Health Literacy Conference (e-Poster, Oral)

Smith, C.; Goss, H.R.; Issartel, J.; Belton, S. (2021) Adolescent Health Literacy Demonstration Project. Schools for Health in Europe Academy: Health Literacy in Schools (e-Poster, Oral)

Belton, S.; Goss, H.R.; **Smith, C.** (2021) LifeLab: Empowering Adolescents to Transform their Health. PPI Ignite Network Summer School (Oral)

Smith, C.; Goss, H.R.; Issartel, J.; Meegan, S.; Belton, S. (2022) LifeLab: Co-Design of an Interactive Health Literacy Intervention for Socioeconomically Disadvantaged Adolescents. Annual All Ireland Postgraduate conference in Sport Sciences, Physical Activity and Physical Education (Poster, Oral)

Smith, C. (2021) Empowering Adolescents to Take Control of Their Health. Tell it Straight Final, Dublin City University's Postgraduate Research Communication Competition (Oral, 2nd Place)

Thesis Structure

This thesis consists of seven chapters. Chapter 1 provides a brief introduction and background to the PhD, as well as the aims and objectives of the research. Chapter 2 provides a critical review of the related literature and the rationale for the proceeding research studies. Chapter 3 details the methodological framework underpinning the studies carried out as part of this thesis and the position of this thesis as part of the wider adolescent HL project. Chapters 4, 5 and 6 detail the three research studies that form the body of this work.

The first study in this PhD (chapter 4) details a systematic review of school-based HL-related interventions targeting socioeconomically disadvantaged adolescents, which aimed to identify effective intervention strategies for this population.

The second study (chapter 5) describes the co-design and formative evaluation of the LifeLab learning activities with, and for, socioeconomically disadvantaged adolescents in order to guide refinements and inform the intervention design and implementation.

The third, and final, study included in the thesis (chapter 6) presents the findings from a mixed-methods process evaluation examining the acceptability, fidelity, dose delivered, reach and effectiveness of a nine-week school-based HL intervention for low socioeconomic adolescents named LifeLab.

Chapter 7 synthesises the key findings from the individual studies and discusses the overarching themes that emerged from the PhD that can be used to guide and inform future research. Finally, future research based on the findings is also proposed.

Introduction to the Thesis

Background

The prevalence of non-communicable diseases (NCDs), such as obesity, cardiovascular disease, type-2 diabetes and other chronic illnesses are becoming more prevalent in today's society (Akseer et al., 2020). It has been stated that almost seven in ten deaths are as a result of NCDs, with the age of onset of such complications gradually lowering (Mendis et al., 2015). Although there are many social determinants that impact health risks and health outcomes, none more so than poverty, income, inequalities, education level and an individual's socioeconomic context generally (Lago - Peñas et al., 2021). Research has strongly demonstrated that those from lower socioeconomic status are at far greater risk of initiating and maintaining poorer lifestyle behaviours, and ultimately developing major health complications, than those from more affluent backgrounds (Pampel et al., 2010). This trend appears to be magnifying, with morbidity and mortality rates as a direct result of poor lifestyle behaviours in socioeconomically disadvantaged populations rising rapidly (Niessen et al., 2018). From a public health perspective, early intervention and prevention is crucial to turn the tide and provide individuals with the knowledge, skillsets and resources to live healthier lives (Arena et al., 2015). Adolescence has been identified as a crucial life stage, where many health values, skills and knowledge and lifestyle behaviours are developed and embedded (Sawyer et al., 2012). Evidence has highlighted that many risk factors for NCDs often begin during adolescence, challenging the misconception that adolescents are typically healthy and that lifestyle-related illnesses do not affect them (Akseer et al., 2020). Moreover, there is a continuous widening socioeconomic gap in health indicators in adolescents (Chzhen et al., 2018). In the Irish context, there are clear health disparities in youth across a range of health indicators including: body mass index and health-related fitness (O'Keeffe et al., 2020); sleep (Hargadon & Downes, 2019); substance and alcohol misuse (Dillon, 2019); mental health (Dooley et al., 2015) and; dietary habits (Kelly et al., 2019).

Health Literacy (HL) has been identified as a means to promote health, and empower individuals to take control of their health (Nutbeam, 2000). HL has been defined as an individual’s knowledge, motivation, and competencies to access, understand, appraise and apply health information in order to make judgements and decisions in their everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life (Sorensen et al., 2012). At the centre of this definition is the ability to deal with health information; namely accessing, understanding, critically appraising, and correctly using information. There is growing evidence highlighting the benefits of developing these capabilities early in life, as high levels of HL in young people has been associated with reduced risk of poor health behaviours and better health outcomes (Fleary et al., 2018; Paakkari et al., 2019). Moreover, low socioeconomic status has been recognised as a risk factor for low HL, with an inverse association between socioeconomic status and HL clearly defined (Stormacq et al., 2020). Crucially, HL is a modifiable risk factor that can be learned and developed through educational means and has been recommended as a key concept to reduce health inequalities and inequities across the socioeconomic spectrum (Stormacq et al., 2019). There is, therefore, an urgent need for HL-focused initiatives in young people, particularly for those from low socioeconomic backgrounds.

Schools have long been recognised as an integral means in which to target all adolescents, providing health education and health promotion, regardless of their social, cultural or economic background (St Leger, 2001; Videto & Dake, 2019). A recent policy brief by the World Health Organisation (WHO) identifies several benefits for developing HL in schools, including (i) increased academic performance; (ii) improved health outcomes;

(iii) greater cost-effectiveness (McDaid, 2016). Moreover, the WHO also published a HL report recommending including HL as a core component of the curriculum in order to enable young people to develop the required capabilities to navigate their own health throughout the life course (World Health Organization, 2014). Given the strong rationale aforementioned, and the fact that schools can offer sustainable implementation of HL education over a long period of time, school-based HL interventions are potentially a viable method to improve health behaviours and health outcomes in those most in need (Sørensen et al., 2015).

Despite schools being identified as an ideal setting to promote health, school-based interventions often report mixed or limited effectiveness (Langford et al., 2014). These heterogeneous findings are often said to be a result of an intervention's lack of alignment to the school's needs and desires (Evans et al., 2015), with many health interventions based solely off academic theories and lacking in contextual understanding (Moore & Evans, 2017). As a result, many have advocated for the inclusion of stakeholders in the design and development of health interventions. Such 'bottom-up' approaches increase the likelihood of participant engagement, intervention relevance and subsequent better outcomes (Craig et al., 2008). Although there are many forms of stakeholder involvement, co-design is one approach that recognises the end-users as "experts", providing opportunities for participants to highlight their needs and develop meaningful solutions (Thabrew et al., 2018).

Randomised controlled trials (RCTs) have long been stablished as the gold standard for measuring the effect of an intervention, yet RCTs alone do not provide sufficient information on the reasons behind why an intervention was or was not successful (Craig et al., 2008). The Medical Research Council (MRC) recommends that interventions are developed using a phased approach, whereby interventions are developed to a point where it can be reasonably expected to have a worthwhile effect before measuring effectiveness (Craig et al., 2008). Several factors can impact an intervention's effectiveness, including program design, implementation or the acceptability from the perspectives of the participants or intervention implementers (Moore et al., 2015). By including an evaluation process in the design phase, it allows for the key influences on the intervention's outcomes to be examined, assessed and refined in preparation for implementation in real-world settings (Borrelli, 2011).

Many public health initiatives attempting to develop health awareness and behaviour change through unidirectional communication, such as advertisements or educational booklets, are often ineffective (Ashfield-Watt, 2006; Kelly & Barker, 2016). Models adopted recently by LENScience in New Zealand (Bay et al., 2012) and, in particular, LifeLab in Southampton (Woods-Townsend et al., 2018) have highlighted the value in offering transactional and experiential learning style. LifeLab Southampton was first initiated in 2008 and is based in Southampton General Hospital (UK). Medical research conducted in Southampton has focused on the processes by which the developmental environment affects later risk of ill-health such as obesity or NCD. As a result, LifeLab Southampton was positioned as an educational intervention engaging adolescents in understanding developmental origins of health and disease. LifeLab Southampton is an innovative, hands-on, educational intervention, focused on developing HL through engaging science-related content within a purpose-built lab facility within a large teaching hospital. The intervention has successfully been through a pilot cluster-randomised control trial (Woods-Townsend et al., 2018), and progressed to a cluster randomised control trial (Woods-Townsend et al., 2021). The research within this thesis intends to build on, and be guided by, the success of LifeLab Southampton in order to develop a distinct and contextually relevant LifeLab Dublin (hereafter referred to as LifeLab).

Thus, as part of a wider HL project, this PhD aims to use an iterative, participatory approach to design, develop and evaluate LifeLab; a meaningful school-based HL intervention that meets the needs of adolescents from low socioeconomic populations in Dublin.

Aims and Objectives of the Thesis

The overall aim of this PhD is to co-design, develop and evaluate LifeLab: an engaging and contextually relevant school-based HL intervention for adolescents from socioeconomically disadvantaged populations.

Specifically, the research objectives of the PhD were:

1. To conduct a literature review summarising (i) the importance of health promotion and health education in adolescence; (ii) HL and its potential benefits; (iii) the role of schools and education in developing HL; and (iv) methodological approaches to developing contextually relevant health interventions (Chapter 2)

2. To systematically review the literature on school-based HL-related interventions in adolescents from socioeconomically disadvantaged populations and identify effective intervention strategies previously adopted in this cohort (Study 1, Chapter 4)

3. To co-design and formatively evaluate the specific LifeLab learning activities with, and for, socioeconomically disadvantaged post-primary students, aimed at engaging adolescents in an interactive HL experience (Study 2, Chapter 5)

4. To pragmatically process evaluate the implementation of the LifeLab intervention, a school-based HL program aimed at improving the HL of low socioeconomically disadvantaged adolescents (Study 3, Chapter 6)

5. To gather information from the process evaluation to inform the iterative refinement of the LifeLab intervention for future roll-out (Study 3, Chapter 6)

6. To synthesise the findings from the studies carried out during this PhD; consider their implications for future research and practice; and suggest future research (chapter 7)

Definition of Key Terms

Adolescence: The period of time between the ages of 10 and 19, during which biological and psychosocial maturation occurs, and competencies required for adulthood are developed (WHO, 2001).

Co-Design: Co-design describes active collaboration between stakeholders in designing solutions to a prespecified problem. It promotes citizen participation to formulate or improve specific concerns (i.e., service or product improvement, better prevention activities, more resources, better trained health promotion staff and, evidence informed initiatives) (Vargas et al., 2022).

Formative Evaluation: A formative evaluation is a rigorous assessment designed to identify potential and actual influences on the progress and effectiveness of implementation efforts, and usually occurs during the design or development phase of an intervention (Stetler et al., 2006).

Hands-on Learning: Hands-on learning, also known as experiential learning or active learning, refers to a style of learning in which students are actively engaged in the learning process and are able to apply their knowledge and skills through direct experience. Hands-on learning involves students actively participating in activities and tasks, rather than simply listening to lectures or reading texts (Kolb, 1984).

Health Literacy: Health literacy is linked to literacy and entails people's knowledge, motivation and competencies to access, understand, appraise, and apply health information in order to make judgements and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course (Sørensen et al., 2012, p.3).

Healthy Competition: Healthy competition has been defined as a short activity where the focus is on the learning process rather than the results, and the outcomes are trivial (Shindler, 2009).

Lifestyle Behaviours: Lifestyle behaviours are defined as everyday activities that result from individual's values, knowledge, and norms shaped by broader cultural and socioeconomic context (Jarosz, 2018).

Peer Support: Peer support can be defined as the acquisition of knowledge and skill through active helping and supporting among status equals or matched companions. It involves people from similar social groupings who are not professional teachers helping each other to learn and learning themselves by so doing (Topping, 2007).

Process Evaluation: Process evaluation is a type of evaluation that aims to assess the implementation and delivery of a program or intervention. It involves collecting and analyzing data on the processes and activities involved in implementing the program or intervention, as well as the context in which it is delivered (Linnan & Steckler, 2002).

Social Determinants of Health: Social determinants of health refer to economic and social conditions that influence an individual and group differences in health status (Krieger, 2001).

Vignettes: In research contexts vignettes are primarily associated with the idea of descriptive episodes simulating real events that are presented either in a written or visual form. In some instances, the term 'vignette' is used interchangeably to include terms such as scenarios, stories, case studies, or other variations (Skilling & Stylianides, 2020).

Philosophical Positioning

It is important to recognise my own experiences and philosophical positioning when considering the research designs, outcomes and interpretations of this PhD. This may be particular salient in study 2 and 3 when I am analysing and interpreting the qualitive data obtained from the stakeholders. Moon and Blackman (2014) discuss how philosophical perspectives, a system of generalised views of the world, are formed from ontology (the study of being) and epistemology (the study of knowledge), with these philosophical positions in turn guiding beliefs and actions. Throughout my undergraduate (BSc Sports Science and Health) and postgraduate degrees (MSc Clinical Exercise Physiology), I developed a positivist approach to my studies and knowledge acquisition. Over the course of the PhD, however, my philosophical orientation has developed and has become much more fluid. The subsequent interpretations made throughout this PhD will have been influenced by my own experiences and understandings. Resultingly, it is essential to state that I view myself as a pragmatic researcher, recognising that there are many different ways to interpreting the world and undertaking research, and that no single viewpoint can ever give the entire picture as there may be multiple realities (Saunders et al., 2019). As such, I appreciate that positivism and interpretivism are two mutually exclusive paradigms about the nature and source of knowledge, and that the research questions are the most important determinants of the research philosophy. Pragmatists, therefore, link the approach chosen directly to the purpose and nature of the aim of the research. Furthermore, pragmatic research advocates for knowledge construction using practical solutions to applied research questions, rather than being driven by epistemological approaches (Giacobbi et al., 2005). Pragmatists place their research questions at the centre of a study and choose an epistemological methodology that they feel is optimal for answering them (McCaslin, 2012). Adhering to pragmatism, the primary objective of research is to generate knowledge that is practically useful for the target audience and the practitioners that support them (Badley, 2003). The knowledge and experience that I (and the research team) have developed in relation to health intervention development, health literacy and the Irish school's system, allowed me to operate as competent practitioner, facilitating novel and innovative insights (Bryant, 2009). This allowed me to combine my applied experience with relevant literature, placing myself as a key co-constructor of knowledge to generate practically meaningful information. Reflecting this pragmatic research philosophy and the aim of this PhD research, a predominantly qualitative approach was employed, which provided the platform for the key stakeholders and the research team to work together to develop research and practical solutions that were suitable and applicable.

Chapter 2: Literature Review

This chapter aims to review the literature related to socioeconomic status and health; the importance of developing positive health-related habits during adolescence; the importance of health literacy; the potential role of health literacy in developing positive health-related habits; and schools as a possible setting to host health and health literacy interventions.

Non-Communicable Diseases: the emergence of a societal problem

The global burden of non-communicable diseases (NCDs) is a growing public health crisis that requires immediate international action (Akseer et al., 2020). NCDs are typically the result of a combination of physiological, behavioural, environmental, and genetic factors, and are the leading cause of mortality globally (Dick & Ferguson, 2015). Analysis carried out in 2012 highlighted that 38 million people died as a result of NCDs, 68% of the total deaths in that year (Mendis et al., 2015). Furthermore, over 40% of those deaths (16 million) were classified as premature and under the age of 70 (Mendis et al., 2015). There are four major NCDs which are responsible for the majority of deaths. These include cardiovascular diseases, some forms of cancer, type-2 diabetes, and respiratory disease (Budreviciute et al., 2020; Mendis et al., 2015). These four forms of chronic disease resulted in over 80% of NCD-related mortalities, with cardiovascular disease by far the greatest contributor (46%), followed by cancers (22%) and chronic respiratory disease (9%) (Mendis et al., 2015). Most NCDs share predisposing risk factors such as obesity, excessive sedentary behaviour, insufficient physical activity, poor dietary habits, substance misuse and inadequate sleep (Arena et al., 2015; Bennett et al., 2018; Budreviciute et al., 2020).

Socioeconomic Status and Health

Social determinants of health refer to economic and social conditions that influence an individual and group differences in health status (Krieger, 2001). The World Health Organisation (WHO) has highlighted that social determinants of health are conditions in which people are born, grow, live, work and age (Wilkinson & Marmot, 2003). Multiple factors have been identified as social determinants of health, including socioeconomic context, inequality, poverty, social exclusion, income, public policies, education, employment status, housing, the environment, health behaviours and social and community support networks (Lago - Peñas et al., 2021). With regards to NCDs, research has strongly linked socioeconomic status and NCD risk, with individuals from lower socioeconomic populations at greater risk of engaging in poorer lifestyle behaviours and subsequently developing health complications than those from more affluent backgrounds (Pampel et al., 2010). These risks are heavily influenced by structural determinants, with the literature highlighting that the strongest determinants of health are structural factors such as national wealth, income inequality, social welfare systems, and access to education (Viner et al., 2012). Structural determinants generate social stratification, which in turn impact on proximal determinants, including quality of family environment and peer relationships, and availability of food, housing and recreation (Marmot et al., 2008). These structural and proximal determinants of health, which fall under the umbrella term of social determinants of health, establish individual differences in exposure and vulnerability to factors that compromise health (Viner et al., 2012). This highlights the importance of considering an individual's social and economic context when assessing or tackling their lifestyle 'choices'.

Approximately 80% of deaths from NCDs occur in low socioeconomic populations, clearly demonstrating the magnitude of the problem (Lago - Peñas et al., 2021). It appears that the seriousness of the situation is worsening as premature death and disability in low socioeconomic populations increases (Niessen et al., 2018). In an effort to counteract this trend, the United Nations has pledged to reduce social and health inequalities between and within countries, with the reduction of socioeconomic inequalities improving health at a population and household level, and the reduction of health inequalities therefore enhancing socioeconomic outcomes (Le Blanc, 2015). Nevertheless, the prevailing inequalities in health education, health care and medicines across the lifetime is leading to an accumulation of unequal exposures within health systems in low socioeconomic populations (Niessen et al., 2018). This situation is evident throughout the life course, from antenatal care to death, leading to continuous health risks associated with lower socioeconomic status (Beaglehole et al., 2011). There is, therefore, a need for a proactive approach to health management, rather than reactive to reverse this trend and its impacts (Hanson & Gluckman, 2015).

Targeting Low Socioeconomic Populations

People from low socioeconomic groups not only tend to have poorer health outcomes when compared to people from more affluent backgrounds, but also have poorer outcomes following interventions (Hiscock et al., 2011). In addition, changes in government policy to address unhealthy behaviours of the United Kingdom population resulted in improvements for those in higher socioeconomic groups, however they have had limited success in improving the behaviour of those from lower socioeconomic groups (Buck & Frosini, 2012). Systematic reviews examining lifestyle behaviour interventions among low socioeconomic populations found that though lifestyle interventions can be effective for this population, there was a small effect size (Bull et al., 2014; Michie et al., 2009). Furthermore, Adams et al., (2016) suggested that these poor outcomes following interventions may even increase health inequalities, highlighting the need to tailor health behaviour interventions for low socioeconomic populations. Indeed, evidence suggests that tailoring lifestyle interventions to specific populations can improve effectiveness, including diabetes prevention in Latino communities (Ockene et al., 2012), HIV prevention in African American men (Tobin et al., 2013) and smoking cessation in low socioeconomic populations (Brown et al., 2014).

Despite the identified need to tailor lifestyle interventions to low socioeconomic populations, there is limited evidence informing the design of such interventions (Michie et al, 2009). A recent qualitative synthesis of people with overweight's experiences of weight management identified psychological and environmental barriers and facilitators (Garip & Yardley, 2011). However, only three of the 17 papers included in this review had sampled from low socioeconomic populations, and as such, findings are likely too generic to inform the design of such a tailored intervention. Of the previous studies which have focused on low socioeconomic populations, many have taken place in the USA (e.g., Davis et al., 2005; Miles & Panton, 2006). Whilst some issues are likely relevant to low socioeconomic groups regardless of location, such as cost considerations, it is likely that others will be related to the specific needs of the communities and cultures included, such as American food culture and African American women's religious settings (Davis et al., 2005). Findings from such studies therefore have limited utility in relation to informing the design of lifestyle interventions for other populations, for example in low socioeconomic adolescents in Ireland.

Much of the previous research has not considered the perceptions of the intervention deliverers (Garip & Yardley, 2011; Bukman et al., 2014). Including these views is important to understand the challenges faced in delivering interventions to these populations, rather than focusing solely on the challenges of receiving or following such interventions. One previous study identified a dissonance between the views of health professionals, policy makers, and people with overweight in relation to their beliefs about the most suitable interventions for tackling obesity in the United Kingdom (Greener et al., 2010). Focusing on issues identified by the intervention participants alone may result in the design of an intervention which is not considered useful to the deliverer, and therefore may not be implemented as planned (Coupe et al., 2018). Including both the perspectives of health professionals and targeted population is therefore important to ensure that the design of an intervention for this population is both suitably tailored, and effectively implemented.

Adolescence as an Important Life Stage

Adolescence is considered one of the most rapid phases of human development (Viner et al., 2015). It is a transitional period from childhood to adulthood during which an individual undergoes significant physical, psychological, and emotional changes (Lassi et al., 2015). Although definitions vary, the WHO (2001) defines adolescence in relation to chronological age, stating that it occurs between the ages of 10 and 19, during which biological and psychosocial maturation occurs, and competencies required for adulthood are developed. Steinberg (2014), however, defines adolescence more loosely as the period between the onset of puberty, and the establishment of social independence. Adolescence has also been elongated and divided into three distinct phases by some: early adolescents (~ age 10 – 14 years), late adolescence (~ age 15 – 19 years) and young adulthood (~ age 20 – 24) (Sawyer et al., 2012).

Biological Development During Adolescence

During adolescence, normative and maladaptive patterns can shape future trajectories (Sawyer et al., 2012). Historically, puberty was considered a period of physical maturation, however, it is now recognised that puberty is a much more complex biological process that impacts behaviours, emotional regulation, and overall health (Sawyer et al., 2012). Moreover, the timing of puberty, beyond chronological age, is mostly associated with changes in mental health and lifestyle behaviours in young people (Patton & Viner, 2007). Environmental factors, such as family relations, parental health, marital tensions and the presence of a stepfather can also impact the rate and timing of puberty (Herman-Stahl et al., 2008; Saxbe & Repetti, 2009). Although an in-depth description of the physiological processes is outside the scope of this PhD, it must be acknowledged that the adolescent brain undergoes considerable development during puberty, in particular changes to the neural architecture (Blakemore & Choudhury, 2006). Such processes provide an opportunity for remodelling of the brain structure in response to behavioural, emotional, and social interactions (Blakemore & Choudhury, 2006) that can have a lasting impact on executive functions, including emotional regulation, self-awareness, decision making, multi-tasking and planning (Sawyer et al., 2012).

Adolescence and its Impact on Later Life

Discussions on efforts to tackle the growing NCD epidemic to date have focused mostly on adult populations, with children and adolescents often overlooked (Akseer et al., 2020; Sawyer et al., 2012). This is despite evidence showing that risk factors for cardiovascular disease, type-2 diabetes, stroke, obesity, and other chronic diseases often begin in childhood and adolescents (Uddin et al., 2020), and that lifestyle behaviours (behaviours that positively or negatively impact health) initiated and developed during adolescence are often embedded and tracked into adulthood (Sawyer et al., 2012). In this context, lifestyle behaviours are defined as everyday activities that result from individual's values, knowledge, and norms shaped by broader cultural and socioeconomic context (Jarosz, 2018). The lack of efforts to tackle NCDs in adolescents may be due to the perception that NCDs are 'lifestyle illnesses' and that the youth population are typically considered healthy, leading to modest efforts in assessing their health, lifestyle modification and disease prevention (Akseer et al., 2020). It is estimated, however, that approximately 70% of the premature deaths occurring during adulthood are a result of the lifestyle behaviours that are initiated in childhood and adolescence (Sawyer et al., 2012). For example, the prevalence of overweight and obesity increases considerably during mid-adolescence and into adulthood (Ng et al., 2014). Overweight and obesity represents a significant risk for premature morbidity and mortality later in life, including cardiovascular disease, type-2 diabetes, certain types of cancer and respiratory conditions (Reilly & Kelly, 2011). Substance misuse during adolescence also represents a threat for multiple health outcomes, including chronic diseases and mental health disorders (Lassi et al., 2015). Similarly, insufficient physical activity, low levels of sleep and poor dietary habits in adolescence significantly increase the likelihood of morbidity and mortality from NCDs in adulthood (Allen et al., 2017; Chattu et al., 2018).

The Impact of the Social Context on Adolescence

Both structural and proximal determinants of health affect the health-related behaviours and subsequent health outcomes of adolescents (Viner et al., 2012). The structural determinants of health include national wealth and income inequality, access to education and health services, employment opportunities for youth, and sex inequality (Viner et al., 2012). The proximal determinants, such as the circumstances of daily life, include the quality of the family and peer relationships, availability of food, housing situations, neighbourhood, and the school environment (Viner et al., 2012). Proximal factors are generated by the social stratification that results from the wider structural determinants but are also influenced more locally by cultural and community factors (Marmot et al., 2008). Although many social determinants of health impact an individual's health over the life course, some can play a bigger role than others during adolescence (Sawyer et al., 2012). The social determinants that have been identified as most pertinent include policies and environments that support access to education, provide the necessary resources for health, and create opportunities for adolescents to develop their decision making capacities, autonomy, employment, and human rights (Sawyer et al., 2012). The complex interaction of social determinants of health, as well as the potential risk and protective factors experienced by an individual, explains the growing health disparities between adolescents of different socioeconomic classes (Salam et al., 2016; Sawyer et al., 2012).

The Influential Factors on Adolescent Health

In addition to the well-established influence of peers, parents and the school environment during adolescence (Finan et al., 2018), there are numerous newly emerging environmental and social factors affecting health outcomes. It has been long recognised that the marketing of unhealthy products has targeted adolescents, none more than the tobacco industry (Lovato et al., 2011). There is robust evidence highlighting the dose dependent relationship between the exposure to tobacco products in media and marketing and youth tobacco use (Wellman et al., 2006). Typical forms of marketing include paid placements of products, sponsorship of sporting events and concerts, and colourful packaging (Jackson et al., 2018). As young people are high consumers of entertainment media (Meier, 2011), and are susceptible to media influence due to the growing focus on personal image and identity, marketing companies can take advantage of their likelihood to identify with what a public figure is advertising (Jernigan et al., 2017). Marketing and media smoking content depicts themes that are appealing to adolescents such as independence, rebelliousness, romance, socializing and glamour, with negative implications rarely shown (Charlesworth & Glantz, 2005). Moreover, as adolescents' cognitive capacities and executive function are still under-developed, they often lack the ability to distinguish the reality portrayed in advertisements from real-life experiences (Meier, 2011) and are susceptible to features such as animation, camera cuts, loud music and other stylistic graphics (Jernigan et al., 2017).

This has been demonstrated by the rapid rise in the use of electronic cigarettes by youth in the past decade (Jamal et al., 2017). There is a clear correlation between the increase in advertisements of these products in marketing and the media and the prevalence of their use in young people (Duke et al., 2014; Kornfield et al., 2015). Unlike conventional cigarettes, electronic cigarette marketing is not regulated by the Food and Drug Authority, allowing for these products to be portrayed as "healthy" and having health advantages over traditional cigarettes (Agaku et al., 2017). This is in addition to the fact that electronic cigarettes are marketed using similar themes to those used to promote conventional cigarettes, including content related to social status, sex, glamour, celebrity endorsements and flavours that are appealing to adolescents (Grana & Ling, 2014). The novelty of electronic cigarettes also appears to be attractive to young people, with adolescents reporting curiosity to try electronic cigarettes, regardless of whether they have used conventional cigarettes (Portnoy et al., 2014). Given the susceptibility of adolescents to marketing campaigns and their high media exposure, there is genuine concern over the impact electronic cigarettes could have on young people (Jackson et al., 2018).

Adolescents are recognised as the earliest adopters of communication and information technology, such as mobile phones, instant messaging, and social network applications (Instagram, TikTok, Twitter, Snapchat etc.) in low, middle and high income populations (Anthony, 2011). The expansion of adolescents' social environment, provided by such mediums, poses both real and perceived risks and benefits (Sawyer et al., 2012). Although social media platforms provide a powerful method for young people to communicate with each other (Deters & Mehl, 2013), adolescents are susceptible to the consequences of overuse or inappropriate activity. The negative effects of social media usage can be physical (e.g., decreased levels of physical activity (Iannotti et al., 2009) and sleep disturbances (Pirdehghan et al., 2021)), but the majority of the effects are psychological (Keles et al., 2020). Despite the fact studies have shown the psychological benefits of how social media can enable individuals to express their thoughts and feelings, and to receive social support (O'Keeffe et al., 2011), research has also clearly demonstrated the link between social media use and psychological problems, such as depression, anxiety, and psychological distress (Keles et al., 2020; McCrae et al., 2017). The link between social media and psychological issues in adolescence does not appear to be straight forward, with numerous contributing factors or behaviours involved. These include the amount of time spent on social media, the number of social media accounts, repeated checking for messages, personal investment and addictive or problematic use (Keles et al., 2020). One major issue with social media can be explained using the social comparison theory (Festinger, 1954), which describes how people tend to compare themselves to others to assess their opinions and abilities. Social comparison is particularly common in adolescents, even more so than children and adults (Krayer et al., 2008; Myers & Crowther, 2009). Social media compounds this as it often exposes youth to idealistic portrayals of individuals' lifestyles and image, creating unrealistic expectations and norms. Such exposures have been shown to lead to increased depression, decreased wellbeing, poor body image and eating disorders (McCrae et al., 2017). The emergence of these influential factors highlights the need for young people to develop the knowledge, awareness and capabilities to deal with the demands of the modern world (Manganello, 2008).

Health Literacy

From Literacy to Health Literacy

Literacy is an individual's capacity to read, write and have basic numeracy skills, allowing people to participate and function in society effectively (Kickbusch, 2001). It is estimated that approximately 25% of the adult population globally has poor literacy skills or are completely illiterate (Kickbusch, 2001). In addition to basic literacy skills needed to function in everyday life, the idea of literacy has been developed to include health literacy (HL). A systematic review carried out to synthesise 17 different definitions of HL provided the following definition: "Health literacy is linked to literacy and entails people's knowledge, motivation and competencies to access, understand, appraise, and apply health information in order to make judgements and take decisions in everyday life concerning healthcare, disease prevention and health promotion to maintain or improve quality of life during the life course" (Sørensen et al., 2012, p.3). HL has only been discussed in detail in the literature over the past 20 years (Stormacq et al., 2020). As HL has been strongly linked with the social determinants of health, health behaviours and health outcomes (Sorensen et al., 2012), the concept has many potential implications for health care, health education and health promotion (Nutbeam, 2000). Due to its potential implications and impact, HL is considered considered one of the major issues in public health and is increasingly being recognised in recent public health policies and initiatives (Stormacq et al., 2020).

Health Literacy Skills and Dimensions

Similarly to general literacy skills, Nutbeam (2000) has categorised HL skills as functional, interactive and critical HL. Nutbeam (2000) describes the three sets of HL skills as such:

- Functional HL describes the basic level skills that are required for individuals to obtain relevant health information, often through reading and writing. For example, functional HL provides the skills to understand information on health risks and how to use the health service and apply that knowledge where necessary. Individuals with these basic HL skills can respond to communication and education that contain clear goals and guidelines, such as medication adherence, participation in prevention activities and some behavioural change.
- Interactive HL describes more advanced cognitive and literacy skills, allowing an individual to participate in everyday activities, extract meaning and derive meaning from different forms of communication, and to apply new information to changing circumstances.
- Critical HL skills are more advanced cognitive skills, which, together with sufficient social skills, can be used to critically analyse information. These skills can be used to exert greater control over more complex life situations and events.

The different types of HL represent different levels of knowledge and skills that an individual possesses, allowing for greater autonomy and personal empowerment. Enhancement of the three forms is not solely dependent on cognitive development, but also exposure to different life situations and scenarios.

Sørensen et al., (2012) used an integrative conceptual model (Figure 2.1) to describe the HL skills that are essential to maintain good health and function effectively in a health system. The model focuses on health care, disease prevention and health promotion, considering both the community and clinical settings. Based on the definition proposed by Sørensen et al., (2012), four key HL competencies are required in order to navigate the health continuum. These include (i) Access: the ability to seek, find and obtain health information; (ii) Understand: the ability to comprehend the health information that is accessed; (iii) Appraise: the ability to interpret, filter, judge and evaluate the health information that has been accessed; and (iv) Apply: refers to the ability to communicate and use the information to make sound decisions in order to maintain and promote health. Developing these four HL competencies, which are closely linked to the dimensions of HL distinguished by Nutbeam (2000), allows people to acquire a multitude of social, personal and cognitive skills that are deemed essential for one to gain control of their health, life situations and events. Furthermore, this model emphasises that HL is not simply the ability to read and write, with far more complex competencies required to navigate the three domains on the health continuum as (i) a patient in the healthcare system; (ii) an individual at risk of disease; and (iii) a citizen engaged in health promotion efforts in the community, workplace, education system or political arena, with these essential competencies continuously developed over the life course.

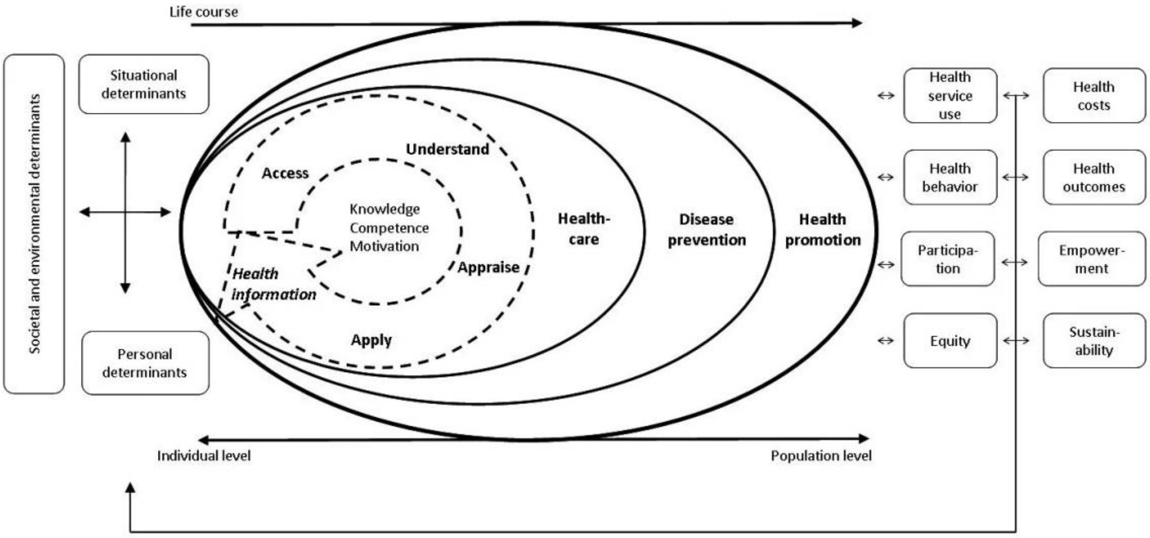


Figure 2.1 Health Literacy Framework as per Sorensen et al., (2012)

Health Literacy as a Public Health Concern

Healthcare systems and society are becoming more and more complex, requiring individuals to develop their literacy in order to use health information effectively to maintain optimal health (McCray, 2005). Constantly people are being asked to become more informed about health issues in society and navigate potential barriers to good health (Kickbusch, 2008). To navigate such barriers and to tackle the ever-changing societal health issues, many abilities and competencies are required, such as information-seeking, communication, critical thinking and problem solving (Sorensen et al., 2012). A good level of HL has been shown to positively influence the ability to effectively navigate the healthcare system through active involvement in discussions with health professionals (Bo et al., 2014), better abilities to self-manage health difficulties (Bohanny et al., 2013), adoption of positive lifestyle behaviours (von Wagner et al., 2007), improved self-efficacy (Osborn et al., 2011), increased preventative health behaviours (Bennett et al., 2009), better health outcomes (Sun et al., 2013), social capital development (Kickbusch, 2008), and lower healthcare costs (Eichler et al., 2009).

According to large scale international data, nearly half of adults in Europe (Sørensen et al., 2015a) and the United States of America (Kutner et al., 2006) have low or limited HL. Low HL levels is associated with an array of negative health consequences including increased mortality (Sun et al., 2013), poor self-report health status (Paasche-Orlow et al., 2010), greater use of emergency services but less preventative services (Berkman et al., 2011), higher rates of chronic disease, and the adoption of poor health behaviours (smoking, substance misuse, sedentary behaviour) (Park et al., 2017). All of which lead to increased healthcare costs (Berkman et al., 2011).

Due to the significant negative consequences of low HL (Sorensen et al., 2012), the positive implications of high HL and the complexities of modern-day living, the importance of HL is increasingly being discussed by policy makers in Europe (Stormacq et al., 2020), and has been recognised as a priority within the strategy of European Commission (Sørensen & Brand, 2011). Moreover, given HL has been identified as a key predictor of health status and health behaviours in the general population (Stormacq et al., 2019), HL has been established as a major determinant of health by the WHO (Marmot et al., 2008). HL is, therefore, a key public health issue that should be at the forefront of future health initiatives, research, actions, and public policy discussions (Kickbusch, 2008).

Health Literacy and Socioeconomic Status

Demographic and social factors, such as socioeconomic status (Nutbeam, 2000; Sørensen et al., 2015a) (which is made up of home address, education attainment, income, and occupation), social support (Lee et al., 2004) and personal characteristics (gender, race and ethnicity) (Nutbeam, 2000), have been closely linked with levels of HL (Sørensen et al., 2015a; Sun et al., 2013). These can have a positive impact on HL, promoting the development of the key HL competencies. Conversely, low socioeconomic status has been recognised as a risk factor for low HL, with an inverse association between socioeconomic status and HL clearly defined (Stormacq et al., 2020). Despite the link between socioeconomic status and HL being well defined (Nutbeam, 2000; Sørensen et al., 2015a), there is a dearth of research assessing individual socioeconomic factors and their association with HL levels. Paasche-Orlow et al., (2005) reviewed the socioeconomic and socio-demographic characteristics that are associated with poor HL, but this study used a limited conceptualization of HL, focusing on reading and numerical skills only and did not consider the mediating role of HL specifically. Stormacq et al., (2019), however, conducted an integrative review to assess the impact of socioeconomic and sociodemographic factors on HL. In the included studies, educational attainment, income, occupation, and perceived social status were addressed. The review highlighted that educational attainment had the biggest impact on HL levels, with those with low level of education were most likely to have low levels of HL. For example, one study within the review (Howard et al., 2006) found that inadequate HL was more prevalent among people without a high school degree than among people with a high school degree. Moreover, HL shows a gradient depending on the level of education (Bennett et al., 2009), with the lower the level of education, the more the risk of low HL increases (Bennett et al., 2009; Van der Heide et al., 2013). Two other studies within the review found that those with lower levels of income were also at increased risk for low HL (Ayotte et al., 2009; Adams et al., 2013). The relationship of employment status with HL was only addressed in one study (Pandit et al., 2009), which stated that those who were unemployed were more likely to have lower HL levels than those who were employed. One study (Zou et al., 2016) examined the association of perceived social status with HL, showing that a lower subjective social status was associated with low HL levels.

Therefore, those at the lowest end of the socioeconomic ladder, with lower education attainment, higher levels of unemployment and a lack of material resources, appear be to be at the greatest risk for low HL skills (Stormacq et al., 2019).

Health disparity has been defined as the differences in health status and outcomes between social groups that are considered unnecessary, avoidable, unfair, and unjust (Braveman & Gruskin, 2003). Health disparities systematically and adversely impact socially and socioeconomically disadvantaged populations (Braveman, 2014). Stormacq et al., (2019) propose that HL may play a partial mediating role in the relationship between low socioeconomic populations and health outcomes, health-related behaviours, and the use of health services. The authors suggest that improved HL can potentially alleviate the effect of certain underlying socioeconomic determinants that contribute to health disparities. Furthermore, it has been suggested that HL may even be a variable that is more amenable to change than other social and economic conditions in these populations (Nutbeam & Lloyd 2021). Stormacq et al., (2019) conclude their argument by stating that improving HL in such populations and making health services more accessible to those with low HL may be a simple practical strategy to reduce health disparities and promote greater health equity. It must be noted, however, that the relationship between various social determinants of health and HL is a very complex, with many influential factors at play (Nutbeam & Lloyd, 2021).

The Issue with Defining and Conceptualising Health Literacy in Adolescents

Although the definition of HL is well defined in adult populations, it is less so in adolescents and young people. A recent qualitative study (Schulenkorf et al., 2022), which involved experts in the field from 32 different countries, aimed to develop an international understanding of HL in adolescents and children, however, the study highlighted that none of the experts had a shared definition for adolescent HL. In addition, the HL framework (Figure 2.1) provided by Sørensen et al., (2012), albeit comprehensive, does not make specific reference to childhood or adolescence, and fails to take into consideration the influence of typical adolescent behaviours such as sensation seeking, poor judgement skills and impulse control (Fleary et al., 2018).

Wharf Higgins et al., (2009) use the socio-ecological model (Bronfenbrenner, 1979) to conceptualise HL in adolescence and childhood. They state that health behaviours in young people are not solely an individual's choices but that they also must consider intrapersonal factors at the micro level (e.g., knowledge and attitudes towards health), interpersonal factors at the meso level (e.g., social support and influences from family, teachers etc.) and community factors at the macro level (e.g., health policies). These findings were emphasised by Schulenkorf et al, (2022), who also used the socio-ecological model (Bronfenbrenner, 1979) to devise a model to conceptualise and operationalise HL in young people. Their qualitive analysis suggested that personal HL (micro level) played the biggest role, with an individual's knowledge, understanding and health-related competencies identified by most experts as key factors. Whereas, interpersonal and organisational level influences were said to only be minor contributing factors, which is contrary to previous research (Edwards et al., 2015), who state that such influences play a major role in an individual's HL.

Despite the lack of conceptual clarity, it is acknowledged that adolescent HL is distinct from adult HL (Bröder et al., 2020). HL is not a static concept, and develops over the life course through education, experiences, societal factors, and personal situations (Okan et al., 2020). As adolescents socialise in different environments, contexts and settings, and are exposed to different health-related life situations to adults, they require a different set of HL-related skills (Schulenkorf et al., 2022). Given this, and the contextual nature of health needs and HL influences (Nutbeam et al., 2018), individual settings should operationalise HL to suit the needs of their specific context.

Importance of Health Literacy in Adolescents

Despite the lack of research carried out to define HL in adolescents, or to explore young people's HL generally (Abrams et al., 2009; Fairbrother et al., 2016), the few studies that have investigated this topic have demonstrated the importance of developing HL at this life stage (Chang, 2011; Fleary et al., 2018). Understanding and promoting HL in adolescents is particularly important for a number of reasons: (i) as adolescents are developing life-long health behaviours and habits, adequate HL skills may support informed health-seeking lifestyles; (ii) adolescents are future independent health care users, and young adults who are health literate may contribute to a generation-level reduction of poor health outcomes known to be linked to low HL levels; (iii) adolescents are already confronted with complex health-related information from various sources, increasing the relevance for youth to become health literate to deal with this information (Ghaddar et al., 2012). Additionally, research by Fleary et al., (2018), which reviewed 13 studies, reported a linear relationship between HL and adolescents' health behaviours including health promoting behaviours, risky sexual behaviours, substance use and information seeking. Others have associated low HL in adolescents with obesity (Lam & Yang, 2014), higher body mass index, greater engagements in problem behaviours (e.g. skipping school) and unhealthy diets (Park et al., 2017).

Young people are frequent users of mass media, which has been shown to influence physical and social development, and has even been cited as a key source of health information for adolescents (Freeman et al., 2018). Due to the pervasiveness and influence of mass media on the lives of adolescents today, it is suggested that adolescents also develop the specific critical thinking and media literacy skills to be able to access health information from mass media, understand the content and evaluate the credibility of the information they obtain (Briandana & Dwityas, 2019). Manganello (2008) emphasises that media literacy, in addition to the core HL skills (functional, interactive and critical HL) proposed by Nutbeam (2000), should also be considered as a crucial component of the adolescent HL framework.

Measuring Health Literacy

The WHO has emphasised the importance of monitoring HL in order to identify the current state of HL in various population groups (Griebel et al., 2018). However, the development of an appropriate, accurate and reliable HL measurement tool is currently lacking, with some suggesting the reason being the lack of conceptual clarity (Okan et al., 2018). Three measurement tools have been commonly used in adults, including the Test of Functional HL in Adults (TOFHLA) (Parker et al., 1995), the Rapid Estimate of Adult Literacy in Medicine (REALM) (Davis et al., 1993) and the Newest Vital Sign (NVS) (Weiss et al., 2005). These measures, however, are most applicable in healthcare settings as their purpose is to screen for 'health-related' literacy, and do not perform well in a non-clinical context (Okan et al., 2018). Moreover, many have been critical of both the quality and quantity of these available tools (Altin et al., 2014; Haun et al., 2014; Ormshaw et al., 2013) and others have commented on the fact that they do not measure all dimensions of HL (Okan et al., 2018). The most comprehensive, multi-dimensional HL measurement tool for the adult general population appears to be the European Health Literacy Survey Questionnaire (HLS-EU-Q) (Sørensen et al., 2013). The HLS-EU-Q, which aims to capture a broad health perspective, measures HL in terms of the three domains where people's health is of concern (functional, interactive and critical HL) and is expressed in terms of accessing, understanding, appraising and applying information to manage disease risk and health (Sørensen et al., 2013). This tool was used to assess HL in eight countries across Europe, highlighting that 12% of respondents had insufficient HL and almost half (47%) had limited or problematic HL (Sørensen et al., 2015b).

Measuring Health Literacy in Adolescents

While the HLS-EU-Q (Sørensen et al., 2013) has been shown to be useful in adult populations, its appropriateness for adolescents is limited. Domanska et al., (2018) investigated the applicability of the HLS-EU-Q47 in Germany on 20 adolescents aged 14-17. They conducted a series of cognitive interviews and identified issues with comprehension as the participants didn't recognise some of the terms used.

As adolescent HL is distinct from adult HL, age specific measures are required (Spillane et al., 2020). Similar to adult HL measurement tools, the majority of the tools used in children and adolescents do not measure functional, critical and interactive HL, with most only measuring functional HL (Guo et al., 2018). Given adolescents require less competencies in dealing with medical services, HL tools must be considered from a health education and health promotion perspective rather than a healthcare or disease management perspective (Ormshaw et al., 2013). The inclusion of measurements to assess interactive and critical HL skills is, therefore, crucial to capture information on whether an adolescent is prepared to maintain and promote good health (Guo et al., 2018).

Guo et al., (2018) carried out a systematic review to assess the quality of available tools used to assess adolescent HL, and to identify the best instrument for field use. The authors highlighted the difficulties in drawing a definitive conclusion about which measurement tool is the most appropriate and best suited to measure HL in adolescents due to the poor methodological quality of studies and a lack of clear reporting. Although the REALM-teen (Davis et al., 2006) and NVS (Driessnack et al., 2014; Warsh et al., 2014) have been relatively well validated and commonly used in adolescent populations, both only measure functional HL and, as previously discussed, are best suited to clinical settings. The review by Guo et al., (2018) also found that of the developed and validated instruments, only nine measured functional, interactive, and critical HL domains, with the Health Literacy for School-Aged Children (HSLAC) (Paakkari et al., 2018) identified as being potentially the most suitable tool for school-based assessment due its quick administration, satisfactory reliability, and one-factor validity. The HLSAC, however, relies on self-reporting, and it has been suggested that the measurement of HL via task-performance is superior to just solely self-reporting measures (Ormshaw et al., (2013). Furthermore, Spillane et al., (2020) highlighted the fact that the HLSAC's applicability has not been thoroughly tested and that the tool was not designed using a grounded co-design approach. The co-design approach allows for the young people to input into the design and development of the measure, ensuring that it is contextually relevant and that the strengths and weaknesses of the target population are met (Altin et al., 2014; Nutbeam et al., 2018). Currently, a research group in Ireland are aiming to develop an adolescent HL questionnaire that will serve the context and needs of the local young people (Spillane et al., 2020). Specifically, they are aiming to develop a tool that is sensitive to a wide range of HL needs of adolescents, including potential key mechanisms to support intervention development, as well as measuring intervention effects. To achieve this aim, the research group are using a validity driven approach by working with local adolescents to allow the target population to be actively involved in the research process (Buchbinder et al., 2011). This approach ensures relevance for the specific context and aligns core health promotion principles, including empowering, participative, holistic, and equitable.

Health Literacy Levels in Adolescents

As a result of the aforementioned issues with measuring HL, the national and international data on adolescent HL levels is very limited. The Health Behaviour in School-aged Children (HBSC) study, which was carried out in 2017/2018, measured HL levels of 15 year-old adolescents (Paakkari et al., 2020). Using the ten-item HSLAC survey, the study assessed the HL levels of male and female adolescents from ten different European countries. Furthermore, the associations between HL, family affluence, gender and self-rated health were also observed. The results of the study indicated that of the school-aged children assessed (n = 14,590), 13.3% had low HL, 67.2% had moderate HL and 19.5% had high HL. The comparative scores for each country can be seen in figure 2.2 below. The results suggest that, of the countries studied, Turkey (18.4%) and Czechia (17.4%) had the highest prevalence of low HL, while Macedonia (38%) and Finland (37.9%) were found to have the highest prevalence of adolescents scoring at a high level of HL. Finland and Macedonia also had the fewest number of adolescents scoring low HL. Interestingly, all countries in the study appeared to have very high proportions of school-aged children with moderate HL levels.

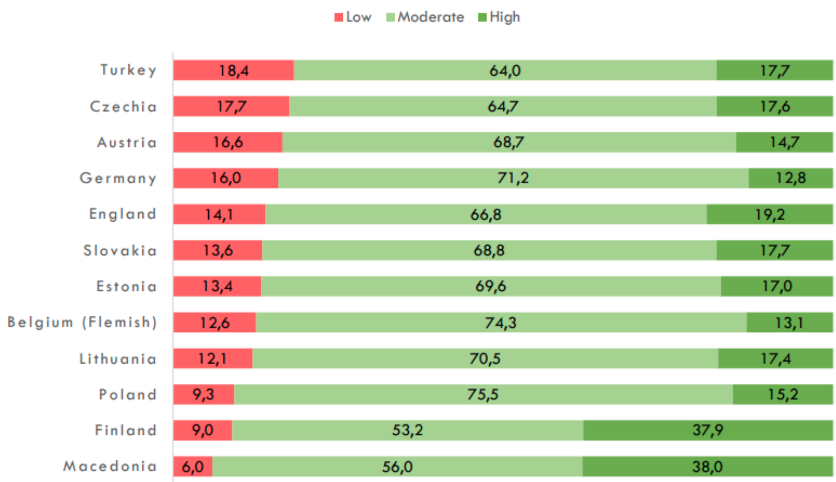


Figure 2.2. Comparative results (%) on health literacy in European adolescents (Okan et al., 2020).

The findings regarding gender differences were mixed. Results from Lithuania, Germany, Poland, Macedonia and Estonia suggested that females had higher levels of HL, yet other countries reported no differences. Moreover, the analysis clearly demonstrated the existence of a social gradient, with adolescents from lower socioeconomic populations reporting lower levels of HL. HL also explained the differences in self-rated health, with those with the highest levels of HL also having the highest levels of self-reported health (Finland and Macedonia). A link between low socioeconomic status and low self-reported health was also highlighted.

Health Literacy in an Educational Context

Schools as a setting for Public Health Interventions

Schools are often recognised as the ideal location for public health interventions (Pulimeno et al., 2020). Schools can reach many children over a long period of time, making them an ideal setting for interventions to foster healthy habits and improve health outcomes (WHO, 2016). In schools, young people from all different socioeconomic populations and cultural backgrounds can be reached, in theory, ensuring all attendees receive equal support, opportunities and attention (Kickbusch et al., 2013). Given the association between health and many social determinants of health (including socioeconomic context, inequality, poverty, social exclusion, income, public policies, housing, the environment, social and community support networks), this is of utmost importance as the school setting provides the opportunity to reach those most in need (Sørensen et al., 2015a). Furthermore, schools can warrant the long-time implementation of public health interventions, and often have the necessary resources do so (staff, facilities, and equipment), ensuring educational programmes can be sustainable and cost effective (McDaid, 2016).

The school system is a strategic environment that can impact young people's health and wellbeing; however, schools have typically focused on cognitive and academic achievements more so than health promotion (Adams et al., 2015). However, the wellbeing of the students also has a major impact on their learning outcomes and, therefore, should not be neglected (Adams et al., 2015). Therefore, health promotion can't remain a marginal aspect of student learning as it has the potential to create a positive environment that potentially allows students to reach better academic attainments and to improve health outcomes. Additionally, young people who perform well at school seem to enjoy better health and have access to more opportunities during their lives (Sklad et al., 2012).

In 2014, the WHO introduced the 'Health Promoting Schools'(HPS) framework; a holistic approach to promoting health and education attainment in schools (Langford et al., 2014). Essentially, the approach aims to target the school curriculum, the ethos and/or school environment, and the families and/or communities. This programme has shown to positively influence students' behaviours, at least for those interventions targeting the following: body mass index, physical activity, fruit and vegetables consumption, prevention of tobacco use and being bullied (Langford et al., 2014). Despite the evidence of the potential benefits of school-based health interventions, there is still a dearth of well-designed health promotion strategies. To improve this, it has been recommended that health-related contents are embedded in the school curricula as core discipline or could be integrated in a health-carrier discipline, such as science, or even delivered as extracurricular programme (Kilgour et al., 2013).

The complexity of the modern world may require a change in teaching and learning practices. It has been suggested that in order to equip students with applicable knowledge and a comprehensive range of life skills, the focus of educational content needs to be shifted from the mere transmission of educational content to active and motivational approaches (Pulimeno et al., 2020). Furthermore, Pulimeno et al., (2020) recommend that teachers master an array of participatory activities such as class discussions, debates, brainstorming, small working groups, peer teaching, co-creating projects, educational games and simulations, storytelling, audio and visual laboratories (e.g., arts, music, theatre, dance etc.), in order to enhance students' health learning outcomes (Pulimeno et al., 2020). To summarise, schools are an ideal location for public health interventions due to their ability to reach a large number of individuals, to influence health behaviours and outcomes, and to create a supportive environment for the delivery of public health initiatives. By prioritizing adequate and appropriate public health education in schools, policy makers and educators can have a significant impact on the health and well-being of young people, and can promote lifelong healthy behaviours (WHO, 2016).

The Relationship Between Health Literacy, Health, and Education

Health and health behaviours cannot be fully explained by one single factor due to their complex nature. HL is one of the many contributing factors to their development and maintenance (Okan et al., 2020). Along with socioeconomic factors, HL has been closely linked to educational indicators, such as school performance and achievement, literacy and learning motivation (Fretian et al., 2020). A model devised by Okan et al., (2020), which is based on WHO frameworks (McDaid, 2016; Suhrcke et al., 2011), aims to depict the impact of HL on health-related attitudes and behaviours, and how such behaviours lead to negative health conditions, which subsequently impact educational outcomes (Figure 2.3). The authors acknowledged the exclusion of crucial macro-level factors (national health, educational policies, cultural context, and national income), instead focusing on the meso- and micro-level factors at play. Despite their exclusion, they state that such macro-level factors should be inherent to any school-based HL framework to ensure a determinants-based approach (Paakkari et al., (2019).

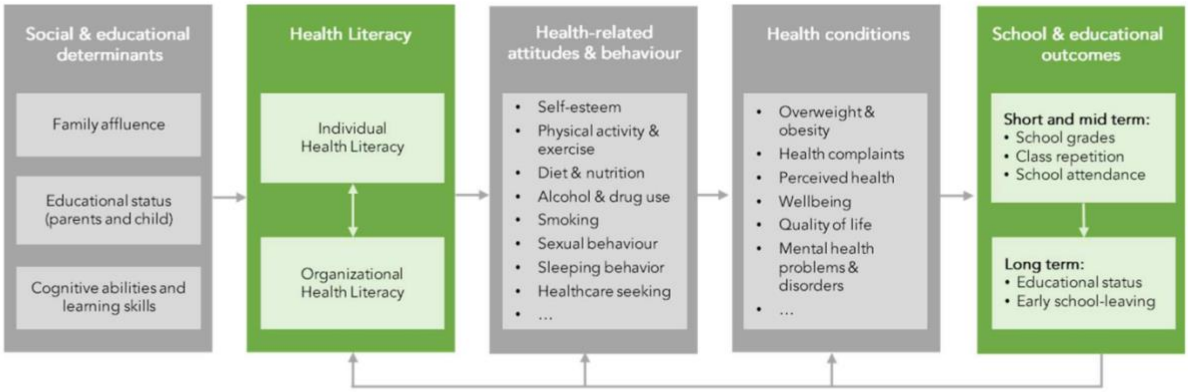


Figure 2.3. The complex interplay between health literacy, health and education (Okan et al., 2020)

The model aligns with the work of Donnelly et al., (2016) and Paakari et al., (2019), who highlight how HL indirectly impacts education through school grades, school attendance and school drop-out rates. Considering the links between HL, health behaviours and health outcomes (Fleary et al., 2018), it can be assumed that HL indirectly affects educational outcomes through health; those with lower levels of HL, are more likely to suffer from ill-health and therefore more likely to perform poorly in school (Okan et al., 2020). Moreover, school pupils who have higher levels of HL, perceive themselves to be healthier, have higher levels of self-esteem, are more satisfied with their lives, have less health complaints and have more health-related knowledge, all of which are associated with better school performance (Paakkari et al., 2020; Paakkari et al., 2019; Santha et al., 2021). These indicators, along the impact of HL levels on levels of obesity, overweight (Shih et al., 2016) and the adoption of poor lifestyle habits (Fleary et al., 2018), demonstrates the indirect association between HL and educational outcomes.

A Call for Health Literacy in the School Setting

Several WHO policy documents have emphasised the important role of HL in the context of school education to promote physical and mental health of the students and staff. In 2013, the WHO published a report entitled “Health Literacy: the solid facts”, which recommended the strengthening of HL levels of school-aged children by including HL as a core component of the whole school approach (Kickbusch et al., 2013). A policy brief on HL in formal education by the WHO Observatory on Health Systems and Policies identified several benefits to including HL in school-based learning, including academic performance, health outcomes and cost-effectiveness (McDaid, 2016). The WHO Shanghai Declaration identified the educational sector as the most important setting for developing HL early in life (WHO, 2017). Finally, a report by the Organisation for Economic Co-operation and Development, “The Future of Education and Skills 2030” identified HL as a core component for the 21st century and a critical target for education in order to empower individuals to take control of their own health (OECD, 2018).

The Impact of Developing Health Literacy in Schools

Although evidence is limited, available research suggests a need to include HL education in schools for adolescents (Bröder et al., 2020; McDaid, 2016; Paakari et al., 2019). Schools can reach many children over a long period of time (WHO, 2016), making them an ideal setting for interventions to develop and strengthen HL capabilities (Paakari et al., 2019). In schools, young people from all different socioeconomic populations and cultural backgrounds can be reached, in theory, ensuring that all receive equal support, opportunities and attention, or such that is proportionate to the degree of their level of disadvantage (Kickbusch et al., 2013; Peralta et al., 2017). Given the association between

HL and low socioeconomic populations, this is of utmost importance as the school setting provides the opportunity to reach those most in need (Sørensen et al., 2015a). Furthermore, schools can warrant the long-time implementation of HL interventions, ensuring educational programmes can be sustainable and cost effective (McDaid, 2016). Such long-term school-based HL programmes have been demonstrated in Finland, USA, and Australia, where a national HL curriculum has been rolled out to ensure that all students are exposed to HL education (Peralta et al., 2021). School health promotion initiatives and health education events have also been linked to HL. This was shown in Lithuania, where pupils who took part in school health promotion activities and health education initiatives reported improved HL levels (Sukys et al., 2019). However, very few school-based programmes or national curricula exist (Okan, 2019). One possible reason for this, may be that schools often view HL education, and health promotion generally, to be substituting time required for teaching core subjects such as math, reading, writing and languages (Okan et al., 2020). This is despite the fact that the goals of HL and the goals of general education overlap on various levels such as aiding in the development of empowered, autonomous and independent citizens, critical thinkers with the ability to reflect on the consequences and ethics of one's actions (Paakari et al., 2019; St Leger & Nutbeam, 2000). Furthermore, researchers involved with LifeLab Southampton (Woods-Townsend et al., 2018) have drawn the link between HL and scientific literacy, which they state has formed the basis for their intervention design and educational content. As such they have highlighted that knowledge of scientific principles relating to human biology, critical thinking and one's ability to make informed decisions on scientific issues, are qualities closely linked with HL (Woods-Townsend et al., 2018). This link further emphasises the overlap between HL and other subjects within the typical school curriculum. Due to the potential impact of HL education, the Schools for Health in

Europe Network Foundation (SHE) emphasises the importance of including HL education as part of a holistic school-based framework that takes into consideration the environment and structures of the school targeted (Okan et al., 2020).

Chapter 3: Methodology

Introduction

This chapter introduces the methodological approaches utilised within this thesis. The value in adopting participatory approaches is first examined, which is followed by the evidence highlighting the importance of evaluating complex interventions (such as LifeLab). The theoretical framework (Optimising Health Literacy Process), which underpins the entire thesis, as well as the wider Adolescent Health Literacy Project, is then introduced and described. The chapter concludes by detailing the foundational research carried out as part of the wider Adolescent Health Literacy Project and how this research has informed and guided the studies documented within this thesis. Finally, the aims and objectives of each study associated with the thesis are detailed, along with the author's contribution to each study.

Why Use Participatory Approaches?

As previously mentioned, schools have been identified as key intervention settings to promote adolescent health and HL (Bonell et al., 2014), however, evaluations of school-based interventions report mixed and often limited effectiveness, irrespective of whether they are mono-component interventions focusing solely on providing health education (Werner-Seidler et al., 2017) or multi-component, aligning with the Health Promoting Schools framework (Langford et al., 2014). Process evaluations of health interventions carried in schools have indicated barriers to implementation that may compromise effectiveness, including lack of philosophical and practical fit with the context and a misalignment with the needs of the targeted school (Evans et al., 2015; Humphrey et al., 2015). It has been recognised that too often health interventions are solely based on established academic theories which are devoid of contextual understanding (Moore & Evans, 2017).

These findings have led to the reconsideration of intervention development to attend to the context in question through the inclusion of stakeholder involvement (Moore et al., 2019; Moore & Evans, 2017), whereby research is carried out “with” rather than “on” participants. Such “bottom-up” methods are believed to lead to interventions based on contextual factors (Moore et al., 2019), which has the potential to increase the likelihood of intervention relevance, participant buy-in, subsequent better outcomes and reduced research wastage (Craig et al., 2008). The use of stakeholder involvement in school-based interventions is rising, with the evidence promising, although still emerging (Bonell et al., 2018; Ozer & Douglas, 2013). The use of stakeholder involvement is a complex, egalitarian approach which involves a range of stakeholders and process (Reed et al., 2021), and although there are varying degrees of stakeholder engagement in participatory research, co-design is commonly understood to provide an opportunity for meaningful end-user engagement throughout the research process (Bakker et al., 2019). Co-design places the user as “the expert of their experiences” and involves more than the participants stating what they want from interventions and being observed doing (to see how they use interventions or services); it involves jointly exploring and articulating needs and jointly exploring and making solutions (Thabrew et al., 2018). In the context of schools and young people, co-design refers to involving the school community and external stakeholders in the design or problem solving phase of the research, with all ideas equally valued throughout the process (Reed et al., 2021). A recent systematic review of participatory approaches in schools identified several consistent benefits for stakeholders, including improved capacity building, problem solving and problem setting skills; social development between stakeholders; increased adoption of co-designed activities from the participants; and enhanced implementation from the teachers (Reed et al., 2021).

The Importance of Evaluating Complex Interventions

Attempts to tackle obesity, smoking and other health issues are increasingly using complex interventions. Complex interventions are commonly defined as interventions that comprise of multiple interacting components (Craig et al., 2008). Randomised controlled trials (RCTs) are regarded as the gold standard to assessing effectiveness in complex interventions, however, RCTs alone do not provide information on how an intervention might be replicated in a specific context or whether trial outcomes will be reproduced (Moore et al., 2015). The MRC strongly recommends including evaluations to assess the 'black box' of complex interventions by taking into account the contextual factors, differences in ways the intervention was delivered and adaptation required for the appropriate delivery in a specific setting (Craig et al., 2008; Moore et al., 2015). Contextual factors typically include features of the environment that influence the delivery or uptake of an intervention. Considering this, it is necessary to aid interpretation of an intervention, maximise the knowledge gained from studies and identify optimal delivery processes that will inform broader dissemination efforts (Beames et al., 2021). Despite this, much of the focus is often on outcome measures, with little consideration given to the evaluation of the processes or design and implementation of an intervention (Rowbotham et al., 2019). This was evident in the systematic review detailed in chapter 4 of this thesis, which highlights the lack of transparency in reporting the process, fidelity and general implementation data related to the school-based HL interventions (Smith et al., 2021).

According to Glasgow & Linnan, (2008), there are two types of evaluation used when designing and evaluating complex interventions. These include formative and process evaluations.

A formative evaluation is a rigorous assessment designed to identify potential and actual influences on the progress and effectiveness of implementation efforts, and usually occurs during the design or development phase of an intervention (Stetler et al., 2006). Formative evaluations help to ensure that an intervention or intervention activity is feasible, appropriate, and acceptable before it is fully implemented (Bauer et al., 2015). They are typically completed with the participants from the targeted cohort, may use qualitative or quantitative methods, and can use a variety of data-gathering tools such as focus groups, interviews, observations, surveys, and emerging data collection such as photovoice and storytelling (Stetler et al., 2006).

Process evaluations are usually carried out during the implementation of an intervention and measure the extent to which an intervention was delivered or the intervention fidelity. Such forms of evaluation provide information on why a program was or was not successful, which is said to be equally as important to the program outcome (Saunders et al., 2005). An intervention may have limited effects due to weaknesses in its design or because it was not properly implemented (Moore et al., 2015). Alternatively, positive impacts can be achieved unexpectedly when an intervention was not delivered as intended. Hence, fidelity data can provide insightful information on the outcome of an intervention (Saunders et al., 2005). Furthermore, the quantity of an intervention implemented and how well an intervention was received by relevant stakeholders are also often captured during a process evaluation (Saunders et al., 2005). As such, process evaluations observe and assess an intervention in detail to provide information on how to refine or adapt the intervention. They also support the preparation for an intervention’s implementation in real-world settings (Borrelli, 2011).

The Optimising Health Literacy (Ophelia) Process

This PhD is part of a wider project that is inspired by the Ophelia process for intervention development (Batterham et al., 2014; Beauchamp et al., 2017). The Ophelia process has been developed to specifically guide the co-design of HL interventions. Ophelia draws upon a set of eight well-established core principles (Table 3.1) and is a flexible guide to help identify health strengths, needs and solutions of a local community (Batterham et al., 2014). Adopting a realist approach (Pawson et al., 2005), Ophelia focuses on contexts, mechanisms and outcomes and consists of low-quality improvement cycles before large scale implementation (Beauchamp et al., 2017).

Specifically, the Ophelia process includes three phases (Figure 3.1), with the eight principles guiding every step within each phase in order to maximise the potential impact on health outcomes and most importantly equity (Beauchamp et al., 2017). Phase one consists of a local needs assessment, using the Health Literacy Questionnaire (HLQ) (Osborne et al., 2013) and semi-structured interviews. The aim of the semi-structured interviews is to explore the thinking underlying the participant's scores on the HLQ. This data captures information on the local HL strengths and areas of need, which is used to generate so-called vignettes. The vignettes demonstrate groupings of strengths and weaknesses across HL domains, as well as demographic background information and lived experiences of a diverse range of individuals within the local population. These vignettes ensure that the data collected is presented as real-life examples of people in the community. The development of the vignettes is followed by a series of co-design workshops with the relevant stakeholders (school staff, students, community workers etc.), in which the vignettes are used to discuss ideas and strategies that could be used to support the vignette character. These ideas provide a pool of potential solutions, generated using local wisdom, to address the health needs of the targeted cohort.

Table 3.1. Ophelia Core Principles as per Beauchamp et al., (2017)

Core Ophelia Principle	Details
Outcomes focused	Improved health and reduced health inequities
Equity driven	All activities at all stages prioritise disadvantaged groups and those experiencing inequity in access and outcome
Co-design approach	In all activities at all stages, relevant stakeholders engage collaboratively to design solutions
Needs-diagnostic approach	Participatory assessment of local needs using local data
Driven by local wisdom	Intervention development and implementation is grounded in local experience and expertise
Sustainable	Optimal health literacy practice becomes normal practice and policy
Responsiveness	Recognise that health literacy needs, and the appropriate responses vary across individuals, contexts, countries, cultures and time
Systematically applied	A multilevel approach in which resources, interventions, research and policy are organised to optimise health literacy

In phase two, based on the project aims and ideas generated from the co-design workshops, program logic models are developed, and rapid literature reviews are conducted to provide evidence to support the selected intervention techniques. Based on the logic model, findings from the review of literature and ideas that emerged from phase 1, detailed implementation and evaluation plans can be developed. These plans are then discussed using co-design workshops with all relevant stakeholders where intervention ideas, materials and processes are refined in preparation for implementation.

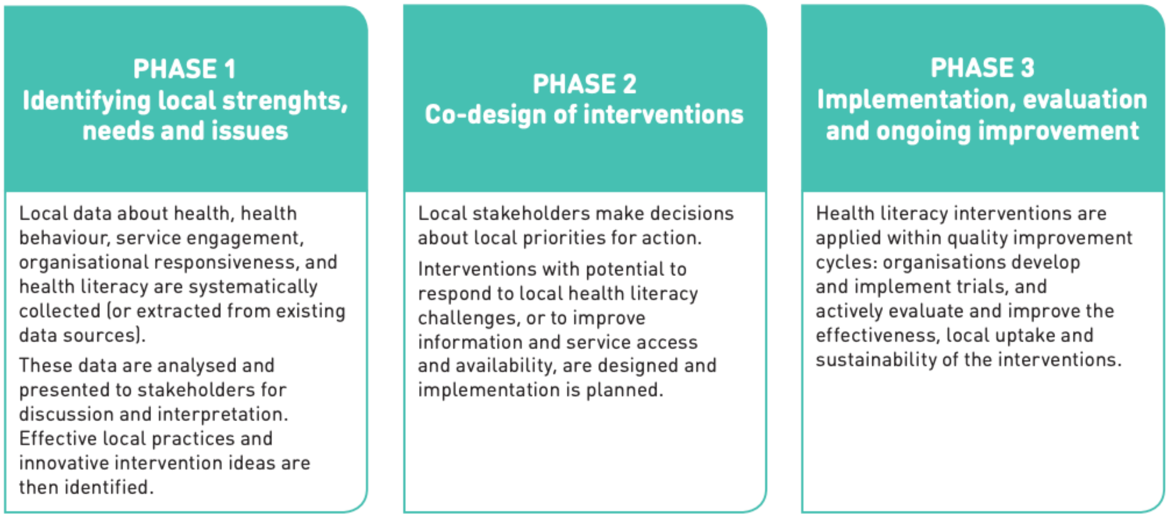


Figure 3.1. Phases of the Ophelia Process (Bakker et al., 2019; Beauchamp et al., 2017)

Phase three of the Ophelia process involves the implementation, quality improvement, evaluation and embedding of the co-designed intervention ideas. This often involves quantitative evaluation methods to assess the intervention's impact, participation rates, delivery, and qualitive methods to discuss the intervention with those who delivered the intervention and the participants involved. Further information on the Ophelia process is detailed elsewhere (Batterham et al., 2014; Beauchamp et al., 2017).

Overview of Adolescent Health Literacy Project

Figure 3.2 provides an overview of this PhD and illustrates how it fits within a broader research project, which is underpinned by the Ophelia process (Batterham et al., 2014; Beauchamp et al., 2017). The overarching aim of the wider project is to co-design a meaningful school-based health intervention to address the HL of socioeconomically disadvantaged adolescents. Prior to the commencement of the studies undertaken as part of this PhD, two foundational studies were conducted. A brief synopsis of these two foundational research studies is detailed below. These studies were the basis for which the three studies within this PhD were built upon.

Foundational Research

Study Title: Understanding disadvantaged adolescents' perception of health literacy through a systematic development of peer vignettes (May 2019 – October 2019)

Citation: Goss, H.R.; McDermott, C.; Hickey, L.; Issartel, J.; Meegan, S.; Morrissey, J.; Murrin, C.; Peers, C.; Smith, C.; Spillane, A.; et al. (2021) Understanding disadvantaged adolescents' perception of health literacy through a systematic development of peer vignettes. BMC Public Health, 21, 593. https://doi.org/10.1186/s12889-021-10634-x.

Synopsis: There is a need to explore, authentically represent and understand the perceptions of health in other contexts, with a view to improving HL. As part of first Phase of the Ophelia framework, the purpose of this study was to explore the perceptions of socially disadvantaged Irish adolescents in relation to HL and related behaviours, and utilise this data to develop relevant robustly, locally developed vignettes. These vignettes are short stories which enable stakeholders to engage in conversations around typically high, average, or low HL individuals in their community. This is a pragmatic realist methodology, which provides an empowering and equitable way to gain rich insight and understanding into factors related to HL. Vignette methodology has been used for many years to explore attitudes, values, norms and perceptions of health issues and other potentially sensitive topics. They enable active and controlled discussion, particularly with young people, as they allow participants to differentiate from themselves, discuss their opinions, and identify in a non-threatening manner. Careful vignette development and interpretation is essential to ensure that they are relevant, realistic, and engaging for participants and that responses are understood as participants shift between speaking about themselves and the character.

Schools were invited on the basis of ensuring a mix of single gender and mixed gender schools, urban and rural schools. Firstly, questionnaires were completed by 962 adolescents (males n = 553, females n = 409, Mean age = 13.97 ± 0.96 years) from five participating local socioeconomically disadvantaged schools in Leinster, Ireland. At the time of conducting this research there was no existing validated adolescent HL questionnaire for use in a non-clinical, adolescent population, readily available in English. As a result, and in line with the Ophelia framework, which suggests that the operationalisation of HL should be flexible and responsive to the contextual needs, the questionnaire used in this study was developed specifically to meet the needs of the study. The questionnaire was developed based on different sources including 10 items from the HLQ developed and administered among adults, 13 items from a questionnaire used for 11–14 year olds in the Healthy Start to Life Education for Adolescents Project, the PACE + two-item questionnaire to measure physical activity levels, along with four demographic questions, and 38 additional items, derived by the research team through consideration of relevant domains and items of the HLQ that were not included in the above, but were considered important to try to interrogate. The majority of these scales used Likert-type response options (e.g. 1 = Strongly Disagree, 2 = Disagree, 3 = Agree, 4 = Strongly Agree). The questionnaire was comprised of 67 questions in total. A subsample of 31 participants from across the five schools were selected by the schools to take part in a focus groups. One focus group was conducted in each school with two students from each of first, second and third year participating; with the exception of one school that had a group of seven students participate in the focus group from across these year groups. The purpose of the focus groups was to identify and explore perceptions and understanding of HL in adolescents in disadvantaged Irish schools. This rich, contextual information was sought to provide in-depth insight into the perceptions of young people in this project. With this in mind, a semi-structured focus group guide, using questions designed by the research team who had specific expertise in qualitative research design, was developed. This included questions to consider understanding (e.g. what is your understanding of the term health literacy?), awareness (e.g. do you understand what you need to do for your health based in the information you find?), strengths (e.g. are there things you do regularly to make yourself healthy?), needs (e.g. is there somebody you can trust to understand and support your questions about health?) and issues in relation to HL and health throughout the school communities. Questions were piloted with two groups of similarly aged students ($n = 16$) from a Youth Advisory Panel recruited by the Irish Heart Foundation. The wording and ordering of questions were refined based on this pilot.

A convergent mixed method design was used to co-create nine vignettes. This design was adopted as it was most appropriate to address the research question. Quantitative and qualitative data was collected, and given the pragmatic nature of working with schools, in practise questionnaires were conducted prior to focus groups. After the completion of data collection, initial data analysis was conducted in parallel, with findings from both questionnaires and focus groups ultimately synthesised and integrated together resulting in the co-production of a series of vignettes. Results were synthesised using cluster and thematic analysis, to develop the vignettes that represented typical male and female subgroups across the schools with varying HL profiles. These vignettes were then validated through triangular consensus with students, teachers, and researchers. The co-creation process was a participatory methodology which promoted the engagement and autonomy of the young people involved in the project. The vignettes provide an authentic and tangible description of the health issues and HL profiles of adolescents in this context. Following a co-design approach, the critical next step in the wider project was to continue to work with participating schools to enable them to overcome the identified HL barriers (the HL weaknesses of the vignettes) and to build on the HL strengths (of the vignettes) to ultimately facilitate positive and sustainable culture change in the targeted population. Hence, the creation of the series of authentic, meaningful, and engaging vignettes was immediately impactful in this project as a method to engage participants in HL research.

Study Title: Using Co-Design to Develop a Health Literacy Intervention with Socially Disadvantaged Adolescents (November 2019 – January 2020)

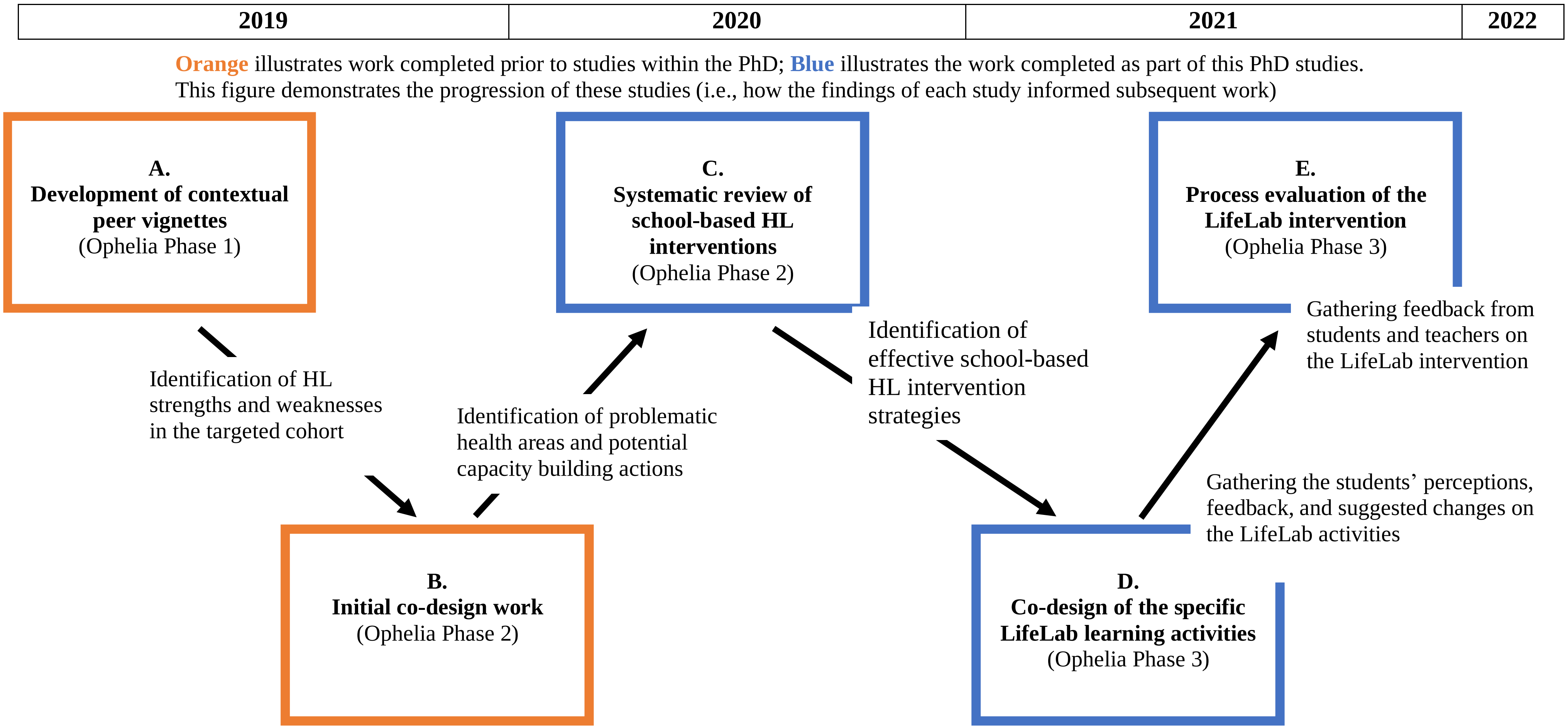
Citation: Goss, H.R.; Smith, C.; Hickey, L.; Issartel, J.; Morrissey, J.; Murrin, C.; Spillane, A.; Belton, S. (2022) Using Co-Design to Develop a Health Literacy Intervention with Socially Disadvantaged Adolescents. Int. J. Environ. Res. Public Health, 19, 4965. https://doi.org/10.3390/ijerph19094965.

Synopsis: This study built on the first stage of the Ophelia process, which is detailed above. As part of the second phase of the Ophelia process, this study aimed to explore the health needs, practices and ideas of students and staff in low socioeconomic post-primary schools in Ireland through co-design workshops to develop a future HL intervention. The study was a descriptive cross-sectional study based on qualitative research methodology. Four post-primary schools (*n* = 3 mixed-gender schools, *n* = 1 all-male school), who were previously purposively recruited to participate in the wider HL project, were involved in this study. Students (n = 33) were recruited through the school project contact as part of the ongoing Healthy Literacy Demonstration Project. There was no strict inclusion or exclusion criteria, but school contacts were asked to identify approximately eight students with a range of diverse backgrounds and interests across the three years of Junior Cycle education (first to third year; age 12–15 years), who would be willing to join the workshops. Recruitment of school staff (n = 33) consisted of the school project contact explaining the project to their staff and identifying and inviting interested school staff to participate. The range of school staff that participated varied slightly by school, but in general included teachers from a range of subject areas (including physical education, science, Social, Personal and Health Education, home economics and maths), as well as Home School Liaison Officers, School Counsellors and School Chaplains. The two co-design workshops per school (one student and one teacher) were conducted separately throughout winter 2019–2020 (prior to the COVID-19 pandemic). The research team developed and followed a structured protocol. At the start of each workshop, as an icebreaker, participants were presented with a range of images and asked to individually select two images that they felt represented “heath issues in your school”. Participants were then invited to introduce themselves to the group and share a brief explanation of why they chose their images. Following this activity, the first vignette was introduced to the group for discussion Vignettes were on average 300 words long and used words and phrases offered by the students themselves in previous focus groups and validation checks. They provided authentic and tangible descriptions of the health topics and HL profiles of adolescents in these specific schools. A series of semi-structured question guides accompanied each vignette discussion, with appropriate wording selected for student and teacher workshops, respectively. Four key areas were covered: (i) is this vignette character familiar? (ii) what sort of issues is this person facing? (iii) what strategies could help a person like this? (iv) what could be done if there are lots of people like this in your school? Question prompts specific to the vignette’s character were also employed as needed. Where appropriate, the facilitator referred to text and images to stimulate conversation. With approximately 15 min to go, the workshop was brought to a close by asking participants “which are the three most important ideas that you have come up with?" and "what are the three easiest ideas to implement in your school?" from across all the vignettes.

The research team conducted content analysis of the discussion that took place in each workshop. Firstly, student and school staff perceptions were identified within each workshop by the co-facilitator, which were presented back to participants towards the end of the workshop. These points were interpreted, critiqued, additions made and agreed upon by participants themselves to promote authenticity of findings. After completion of each workshop, the critical observer also offered insight to the research team as to any ideas or inferences that may have been missed. The recordings were subsequently listened to and cross referenced with the notes from the co-facilitator and critical observer to abstract the key points from each workshop. After completion of all workshops, researchers synthesized findings through reflexive discussion into common concepts. Participants indicated that five key health topics were especially relevant in this context (in no particular order): food choices, mental health and wellbeing, physical activity and sedentary behaviour, sleep and substance misuse. Capacity building actions, i.e., tangible and pragmatic solutions, were suggested by participants in relation to the HL needs of individuals and populations in this context both in relation to specific health topics and in relation to health more widely. These include interactive, applied, and relevant activities; fun and engaging off-site delivery; and education around the short- and long-term impact of health behaviours. The capacity building actions offered by participants were considered as potential intervention strategies that could be applied across the health topics identified in this context. Specifically, findings from this study, both health topics and capacity building actions, will directly inform the development of the HL intervention for socioeconomically disadvantaged Irish post-primary schools as part of this thesis.

The findings from these two foundational studies provided a platform from which the work in this PhD could build from. The initial study identified the HL strengths and weaknesses of typical adolescents in the target cohort, as well as a series of tangible vignettes that could be used throughout the intervention to co-design specific elements of the intervention. The following study identified key health areas to focus on and broad strategies or ideas that could be used to develop HL through a school-based intervention. This PhD project intended to use these findings, and the existing literature, to further co-design and evaluate a school-based HL intervention that would meet the HL needs of socioeconomically disadvantaged adolescents. Table 3.2 details the author's role in both the foundational and PhD studies.

Figure 3.2. Overview of the Adolescent Health Literacy Project



Title of research studies:

A. Understanding disadvantaged adolescents' perception of health literacy through a systematic development of peer vignettes
B. Using Co-Design to Develop a Health Literacy Intervention with Socially Disadvantaged Adolescents
C. Health Literacy in Schools? A Systematic Review of Health-Related Interventions Aimed at Disadvantaged Adolescents (Study 1, Chapter 4)
D. LifeLab: Co-Design of an Interactive Health Literacy Intervention for Socioeconomically Disadvantaged Adolescents' (Study 2, Chapter 5)
E. A process evaluation of LifeLab; an interactive health literacy intervention for socioeconomically disadvantaged adolescents (Study 3, Chapter 6)

Aims and Objectives of the Studies

Overall Research Aims:

To co-design, develop and evaluate LifeLab: an engaging and contextually relevant school-based HL intervention for adolescents from socioeconomically disadvantaged populations.

Research Study Objectives:

1. To systematically review the literature on school-based HL-related interventions in adolescents from socioeconomically disadvantaged populations and identify effective intervention strategies previously adopted in this cohort (Study 1, Chapter 4)

2. To co-design and formatively evaluate the specific LifeLab learning activities with, and for, socioeconomically disadvantaged post-primary students, aimed at engaging adolescents in an interactive HL experience (Study 2, Chapter 5)

3. To pragmatically process evaluate the implementation of the LifeLab intervention, a school-based HL program aimed at improving the HL of low socioeconomically disadvantaged adolescents (Study 3, Chapter 6)

Author's Role in Each study

Table 3.2. The author's role through each research study

Research study	Author's Role (Craig Smith)
Understanding disadvantaged adolescents' perception of health literacy through a systematic development of peer vignettes (Foundational Study)	Design: Decided by wider team (prior to PhD starting) Selection of methods and measures: Decided by wider team (prior to PhD commencing) Data collection: Author assisted with collecting qualitative data to validate the vignettes (initial data collected prior to PhD commencing) Analysis: Author assisted with data analysis, in particular analysing and developing vignette narratives Write up: Dr. Hannah Goss led with the writing process of the published manuscript
Using Co-Design to Develop a Health Literacy Intervention with Socially Disadvantaged Adolescents (Foundational Study)	Design: Decided by the wider team, with input from the author Selection of methods and measures: Decided by the wider team, with input from the author Data collection: Author assisted with data collection Analysis: Analysis led by Dr. Hannah Goss with input from the author Write up: Author assisted with the writing of the published manuscript
(Study 1, Chapter 4): Health Literacy in Schools? A Systematic Review of Health-Related Interventions Aimed at Disadvantaged Adolescents	Design: Dr. Hannah Goss designed the study, before receiving input from the wider team Selection of methods and measures: Discussed and agreed between author and Dr. Hannah Goss before receiving input from the wider team Data collection: The author and Dr. Hannah Goss collected the data. Analysis: The author completed the analysis of the data Write up: The author led the writing process for the published manuscript

(Study 2, Chapter 5): LifeLab: Co-Design of an Interactive Health Literacy Intervention for Socioeconomically Disadvantaged Adolescents'	Design: The author and Dr. Hannah Goss designed the study with the input of the wider team. Author led on the design of the LifeLab learning activities Selection of methods and measures: Discussed and agreed between wider team Data collection: The author and Dr. Hannah Goss collected the data Analysis: The author analysed all the data Write up: The author led the writing process for the published manuscript
(Study 3, Chapter 6): A process evaluation of LifeLab; an interactive health literacy intervention for socioeconomically disadvantaged adolescents	Design: The author designed the study with the input of the wider team Selection of methods and measures: The author selected the methods and measures with input from the wider team Data collection: the author and wider team collected all data Analysis: The author analysed all the qualitative and quantitative data. Write up: The author led the writing process for the submitted manuscript

Chapter 4: Health Literacy in Schools? A Systematic Review of Health-Related Interventions Aimed at Disadvantaged Adolescents

Health Literacy in Schools? A Systematic Review of Health-Related Interventions Aimed at Disadvantaged Adolescents

Research Question:

What are the effective intervention strategies that have been used in school-based HL-related interventions in adolescents from low socioeconomic populations?

Abstract:

Socioeconomically disadvantaged populations are at greater risk of adopting unhealthy behaviours and developing chronic diseases. Adolescence has been identified as a crucial life stage to develop lifelong healthy behaviours, with schools often suggested as the ideal environment to foster healthy habits. HL provides a possible solution to promote such healthy behaviours. The aim of this study was to review school-based HL-related interventions targeting socioeconomically disadvantaged adolescents and to identify effective intervention strategies for this population. Searches were performed in six databases. Inclusion criteria included age: 12–16; the implementation of a school-based intervention related to HL aimed at socioeconomically disadvantaged populations; an intervention focused on: physical activity (PA), diet, mental health, substance abuse or sleep. Forty-one articles were included, with the majority focusing on PA and diet (n = 13), PA (n = 9) or mental health (n = 7). Few interventions focused solely on substance abuse (n = 2) or sleep (n = 1), and none targeted or assessed HL as an outcome measure. There was huge heterogeneity in study design, outcomes measures and effectiveness reported. Effective intervention strategies were identified that can be used to guide future interventions, including practical learning activities, peer support and approaches targeting the school environment, the parents or that link the intervention to the community.

Key words: health literacy; adolescent; intervention; socioeconomically disadvantaged; school based.

Introduction

The WHO has recognized the potential role of improved HL in preventing and reducing NCDs by empowering citizens to manage their own health (Organization, 2017). Consequently, the WHO has engaged in numerous actions to promote health through an improvement in HL (Health Organization & Office for Europe, 2013a; Organization, 2017), and has identified the educational sector as the most important setting for teaching and learning HL in early life (Organization, 2017).

Adolescence is a time-period when individuals begin to achieve greater autonomy (Steinberg, 2005). Lifestyle behaviours are developed, established, and ultimately track into adulthood (Sawyer et al., 2012a). Adolescence is also a period when health behaviours and social determinants, such as the ability to stay in education, can have lasting impacts on health equity across the life course (Patton et al., 2016a). Thus, this time period is increasingly recognised as challenging, but also as a window of opportunity to improve HL in order to promote positive health behaviours, and consequently reduce the risk of lifestyle-related diseases (Woods-Townsend et al., 2018). A systematic review investigating approaches to behaviour change interventions in young people from disadvantaged backgrounds found that successful interventions incorporated educational components (Baird et al., 2009), as education has been proven to improve attitudes, develop HL and change health behaviours in youth (Borzekowski, 2009; Don Nutbeam, 2004). Furthermore, life-long behaviours that are developed during adolescence are influenced by educational, biological, cognitive, and socioecological factors (Bay et al., 2017). As a result, the school environment has been identified as the ideal setting for interventions to promote health behaviours and reduce NCD risk (Pearson et al., 2015; Tang et al., 2009). School-based health interventions, however, have reported mixed levels of success (Khambalia et al., 2012). In addition, socioeconomically disadvantaged populations are not only more likely to have poorer health behaviours, but they are also more likely to have poorer health outcomes following interventions and implementation of government policy changes, when compared to more affluent groups (Buck & Frosini, 2012; Hiscock et al., 2011). It has even been suggested that poor outcomes following interventions may actually increase health inequalities (White et al., 2009), further emphasising the need to tailor health interventions for disadvantaged populations; an approach which has been proven effective (Brown et al., 2014; Ockene et al., 2012).

Although previous work has provided recommendations on effective strategies for the implementation of school-based health interventions in the general population, there is a lack of research focusing on interventions specifically targeting adolescents from socioeconomically disadvantaged backgrounds. As per Phase two of the Ophelia framework (Beauchamp et al., 2017), intervention developers are recommended to carry out literature reviews to identify effective intervention strategies with the cohort in question. This study aims to goes above and beyond that recommendation by conducting a full systematic review to comprehensively identify and analyse HL-related school-based interventions in adolescents from socioeconomically disadvantaged backgrounds and to identify effective intervention strategies to improve HL for this population. Of specific interest are interventions aimed at adolescents aged 12 – 16, as this is typically a time period where adolescents in Ireland and the United Kingdom attend their junior years of post-primary education, creating a practical and pragmatic timepoint to intervene during adolescence (Patton et al., 2016).

Materials and Methods

This study was registered with PROSPERO: the international prospective register of systematic reviews (REF: CRD42020184410) and adhered to the reporting guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P) (Moher et al., 2016).

Study Selection Criteria

Inclusion:

Studies identified through the literature search were included if they:

1. Included typical adolescents with a reported mean age between 12 and 16 years
2. Self-reported that the participants were from a socioeconomically disadvantaged (or equivalent) background
3. Included the implementation of an intervention related to health literacy (increases health knowledge, understanding, awareness, motivation, confidence) in at least one of the following areas physical activity, sedentary behaviour, dietary habits, sleeping habits, mental health or substance abuse
4. Included school-based interventions, interventions that could be feasibly implemented in a school setting or interventions that could be linked to a school curriculum
5. Aimed to increase health knowledge/comprehension, understanding, behaviour, value, wellbeing, motivation, self-efficacy or self-monitoring in relation to any of the following domains: physical activity, sedentary behaviour, dietary habits, sleeping habits, mental health or substance abuse

Exclusion:

Studies identified in the literature search were excluded if:

1. They included special populations (e.g., children with learning difficulties, pregnant adolescents, exclusively obese individuals, or those with a specific health condition)
2. The intervention did not include an educational element or a component targeting health literacy (increases health knowledge, understanding, awareness, motivation, confidence)
3. They were book chapters, case studies, student dissertations, conference abstracts, review articles, meta-analyses, editorials, protocol papers or systematic reviews
4. They were not published in English or in a peer reviewed journal
5. The full text article was not available

For full PICO statement see Appendix A..

Information Sources, Search Strategy and Study Selection

Six electronic databases were searched: MEDLINE/PubMed, ERIC, CINAHL, PsychINFO, EMBASE to identify relevant evidence. ‘English’ and ‘peer reviewed’ filters were marked on all searches. The search strategy was developed using Boolean operators (AND/OR), incorporating the relevant terms (Appendix B). The search was not limited to any publication time frame. The search was conducted between June and August 2020. All records were exported to Mendeley reference managing software for screening and all duplicates were removed.

The eligibility of the studies was independently reviewed by the lead author and another member of the research team. Following title and abstract screening, full-text copies of potentially relevant studies were obtained and screened for full text inclusion. In the case of disagreement, a third author was contacted for discussion until consensus was reached. No changes to the eligibility of papers were made based on these discussions.

Data Collection

Following the screening process, the data were extracted into table format. Study data relating to study information, sample information, purpose of study, intervention description, measurement technique, reported outcome variables, intervention fidelity and intervention quality was extracted. The lead author entered the data from the included articles into an evidence table, and the second reviewer then examined the articles and edited the table entries as needed for accuracy.

Quality Appraisal

Each study was assessed for the risk of bias using a modified version of the Cochrane Collaboration's tool for assessing risk of bias (Higgins et al., 2011). The tool was further adapted to remove performance bias as it was deemed inappropriate for the context of this study. Each study was examined for selection bias, attrition bias, detection bias and reporting bias, and ranked as 'low risk' or 'high risk' for each. It was marked 'unclear' if there was insufficient information to make an assessment and marked 'not applicable' if the bias could not be determined based on the design of the study in question. A narrative overview of included interventions is also included.

Results

Study Selection

Figure 4.1 below details the search and screening process. The literature search yielded 8074 publications; after removing 1908 duplicates, 6796 publications were subsequently screened. Of these publications 6417 were excluded based on title and abstract because they did not fulfil one or more of the inclusion criteria. The remaining 379 publications were retrieved for full text review. A total of 338 failed to meet the inclusion criteria. The main reasons for excluding full texts were that the intervention targeted a population which was outside of the age range, or the intervention was not implemented with populations which were socioeconomically disadvantaged. Finally, 41 publications were included for review.

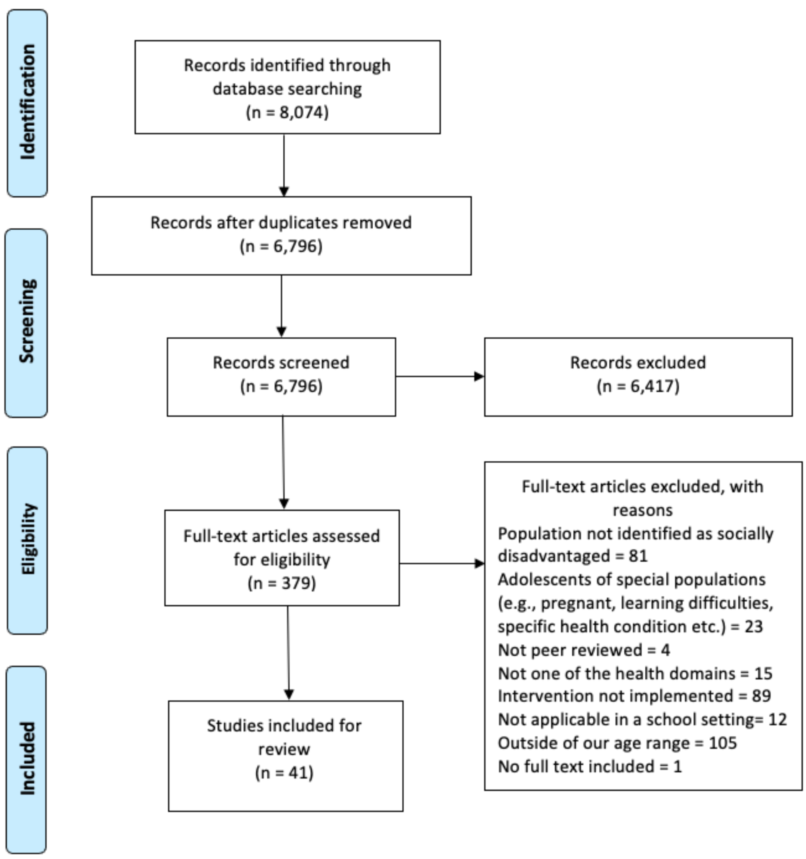


Figure 4.1. Prisma Flow Diagram

Study Characteristics

The study characteristics are summarised in Table 4.1 below. Among the 41 studies, 23 were based in the United States (Alaimo et al., 2015; Baker et al., 2012; Black et al., 2010; Fardy et al., 1996; Frazier et al., 2015; Frenn et al., 2005; Frenn et al., 2003; Issner et al., 2017; Jackson et al., 2010; Kerr et al., 2013; Knapp et al., 2019; Luesse et al., 2019; Mendelson et al., 2015; Pfeiffer et al., 2019; Quante et al., 2019; Robbins et al., 2016; Romero, 2012; Roth et al., 2019; Schleider et al., 2019; Sibinga et al., 2013; Vicary et al., 2004; Robinson, Harper, and Schoeny, 2003), six in Australia (Casey et al., 2014; Dewar et al., 2013; Dray et al., 2017; Hollis et al., 2016; Lubans et al., 2012; Smith et al., 2016), four in Brazil (Bandeira et al., 2020; Berria et al., 2018; Brito Beck da Silva et al., 2015; Leme et al., 2018), two in Sweden (Fröberg et al., 2018; Holmberg et al., 2018), two in India (Sethi et al., 2013; Shinde et al., 2018) and one each in Belgium (Dubuy et al., 2014), Chile (Araya et al., 2013), Spain (Aceves-Martins et al., 2017) and Canada (Beaulac et al., 2011). The year of publication ranged from 1996 (Fardy et al., 1996) to 2020 (Bandeira et al., 2020), with the majority published in the last decade (2020) (n= 35). A total of 22 studies were randomised controlled trials (RCTs) (Aceves-Martins et al., 2017; Araya et al., 2013; Bandeira et al., 2020; Black et al., 2010; Brito Beck da Silva et al., 2015; Casey et al., 2014; Dewar et al., 2013; Dray et al., 2017; Fardy et al., 1996; Hollis et al., 2016; Issner et al., 2017; Kerr et al., 2013; Leme et al., 2018; Lubans et al., 2012; Pfeiffer et al., 2019; Robbins et al., 2016; Roth et al., 2019; Schleider et al., 2019; Shinde et al., 2018; Sibinga et al., 2013; Smith et al., 2016; Vicary et al., 2004), ten employed pretest-post-test quasi-experimental designs (Alaimo et al., 2015; Baker et al., 2012; Berria et al., 2018; Dubuy et al., 2014; Frenn et al., 2005; Frenn, Malin, & Bansal, 2003; Frenn, Malin, Bansal, et al., 2003; Fröberg et al., 2018; Jackson et al., 2010; Mendelson et al., 2015), four employed a single group pretest-post-test designs (Frazier et al., 2015; Luesse et al., 2019; Romero, 2012; Sethi et al., 2013), three were post-test qualitative evaluations (Beaulac et al., 2011; Holmberg et al., 2018; Quante et al., 2019), and the remaining two adopted cross-sectional designs (Knapp et al., 2019; Robinson, Harper, and Schoeny, 2003). All studies assessed the interventions using quantitative techniques, with the exception of five which employed mixed methods (Aceves-Martins et al., 2017; Baker et al., 2012; Beaulac et al., 2011; Jackson et al., 2010; Luesse et al., 2019), and three that used qualitative analysis (Holmberg et al., 2018; Knapp et al., 2019; Quante et al., 2019). The sample size ranged from 15 (Jackson et al., 2010) to 13,035 (Shinde et al., 2018). Twenty-eight of the studies looked at mixed gender samples, while four focused only on males, and nine target females only.

Table 4.1. Study Characteristics

Authors (year)	**Country**	**Study Design**	**Research Type**	**Sample**	**Gender**
(Aceves-Martins et al., 2017)	Spain	RCT	MM	393	M&F
(Alaimo et al., 2015)	US	Pretest-post-test design (Quasi-experimental)	QT	1176	M&F
(Araya et al., 2013)	Chile	RCT	QT	2512	M&F
(Baker et al., 2012)	US	Pretest-post-test design (Quasi-experimental)	MM	46	M&F
(Bandeira et al., 2020)	Brazil	RCT	QT	1085	M&F
(Beaulac et al., 2011)	Canada	Post-test evaluation	MM	67	M&F
(Berria et al., 2018)	Brazil	Pretest-post-test design (Quasi-experimental)	QT	546	M&F
(Black et al., 2010)	US	RCT	QT	235	M

(Brito Beck da Silva et al., 2015)	Brazil	RCT	QT	833	M& F
(Casey et al., 2014)	Australia	RCT	QT	621	F
(Dewar et al., 2013)	Australia	RCT	QT	357	F
(Dray et al., 2017)	Australia	RCT	QT	3115	M& F
(Dubuy et al., 2014)	Belgium	Pretest-post-test design (Quasi-experimental design)	QT	414	M
(Fardy et al., 1996)	US	RCT	QT	346	M& F
(Frazier et al., 2015)	US	(Single group) Pretest-post-test design	QT	46	M& F
(Frenn, Malin, & Bansal, 2003)	US	Pretest-post-test design (Quasi-experimental)	QT	117	M& F
(Frenn, Malin, Bansal, et al., 2003)	US	Pretest-post-test design (Quasi-experimental)	QT	130	M& F
(Frenn et al., 2005)	US	Pretest-post-test design (Quasi-experimental)	QT	103	M& F
(Fröberg et al., 2018)	Sweden	Pretest-post-test design (Quasi-experimental)	QT	114	M& F
(Hollis et al., 2016)	Australia	RCT	QT	1150	M& F
(Holmberg et al., 2018)	Sweden	Post-test evaluation	QL	49	M& F
(Issner et al., 2017)	US	RCT	QT	100	M& F
(Jackson et al., 2010)	US	Pretest-post-test design (Quasi-experimental)	MM	15	M& F
(Kerr et al., 2013)	US	RCT	QT	1654	M& F
(Knapp et al., 2019)	US	Cross Sectional	QL	27	M& F

(Leme et al., 2018)	Brazil	RCT	QT	253	F
(Lubans et al., 2012)	Australia	RCT	QT	357	F
(Luesse et al., 2019)	US	(Single group) Pretest-post-test design	MM	32	M& F
(Mendelson et al., 2015)	US	Pretest-post-test design (Quasi-experimental)	QT	49	M& F
(Quante et al., 2019)	US	Post-test qualitative evaluation	QL	27	M& F
(Robbins et al., 2016)	US	RCT	QT	1519	F
(Pfeiffer et al., 2019)	US	RCT	QT	1519	F
(Robinson et al., 2003)	US	Cross-sectional	QT	1196	M& F
(Romero, 2012)	US	(Single group) Pretest post-test design	QT	73	M& F
(Roth et al., 2019)	US	RCT	QT	3763	M& F
(Schleider et al., 2019)	US	RCT	QT	222	F
(Sethi et al., 2013)	India	(Single group) Pretest-post-test design	QT	60	F
(Shinde et al., 2018)	India	RCT	QT	13035	M& F
(Sibinga et al., 2013)	US	RCT	QT	41	M
(Smith et al., 2016)	Australia	RCT	QT	361	M
(Vicary et al., 2004)	US	RCT	QT	319	F

Quality Appraisal

The quality appraisal of the included studies is summarised in Table 4.2. Many studies were reported as ‘unclear risk’ as they did not provide adequate detail to assess the level of bias. Furthermore, studies which were not RCTs could not be assessed for selection bias as there was no random allocation. Of the studies that were assessed for selection bias, nine reported as ‘low risk’ across both assessments. Due to the lack of information, 15 of studies were reported as having an ‘unclear risk’ of detection bias. Of the remaining studies, seven were reported as ‘high risk’ and 19 as ‘low risk’. The majority (n = 35) were scored as ‘low risk’ for attrition bias, with two reported as ‘high risk’. Reporting bias was reported as ‘low risk’ in all included studies.

Table 4.2. Quality Appraisal

Authors	**Selection Bias**		**Detection Bias**	**Attrition Bias**	**Reporting Bias**
	Random sequence generation	Allocation concealment	Blinding of outcome data	Incomplete outcome reporting	Selective outcome reporting
(Aceves-Martins et al., 2017)	Low risk	High Risk	Unclear Risk	Low risk	Low risk
(Alaimo et al., 2015)	n/a	n/a	Unclear Risk	High Risk	Low Risk
(Araya et al., 2013)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
(Baker et al., 2012)	n/a	n/a	Unclear Risk	Low Risk	Low Risk
(Bandeira et al., 2020)	Unclear Risk	Unclear Risk	High Risk	Low Risk	Low Risk
(Beaulac et al., 2011)	n/a	n/a	Low Risk	Low Risk	Low Risk
(Berria et al., 2018)	n/a	n/a	Unclear Risk	Low Risk	Low Risk
(Black et al., 2010)	Low Risk	Unclear Risk	Low Risk	Low Risk	Low Risk
(Brito Beck da Silva et al., 2015)	Unclear Risk	Unclear Risk	Unclear Risk	Low Risk	Low Risk
(Casey et al., 2014)	Low Risk	Unclear Risk	Unclear Risk	High Risk	Low Risk

(Dewar et al., 2013)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
(Dray et al., 2017)	Low Risk	High Risk	Unclear Risk	Low Risk	Low Risk
(Dubuy et al., 2014)	n/a	n/a	High Risk	Low Risk	Low Risk
(Fardy et al., 1996)	Unclear Risk	Unclear Risk	Unclear Risk	Low Risk	Low Risk
(Frazier et al., 2015)	n/a	n/a	High Risk	Unclear Risk	Low Risk
(Frenn, Malin, & Bansal, 2003)	n/a	n/a	Low Risk	Unclear Risk	Low Risk
(Frenn, Malin, Bansal, et al., 2003)	n/a	n/a	Unclear Risk	Low Risk	Low Risk
(Frenn et al., 2005)	n/a	n/a	Low Risk	Low Risk	Low Risk
(Fröberg et al., 2018)	n/a	n/a	Unclear Risk	Low Risk	Low Risk
(Hollis et al., 2016)	Low Risk	Low risk	Low Risk	Low Risk	Low Risk
(Holmberg et al., 2018)	n/a	n/a	Low Risk	Low Risk	n/a
(Issner et al., 2017)	Low Risk	Unclear Risk	High Risk	High Risk	Low Risk
(Jackson et al., 2010)	n/a	n/a	Unclear Risk	Low Risk	Low Risk
(Kerr et al., 2013)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
(Knapp et al., 2019)	n/a	n/a	High Risk	Low Risk	Low Risk
(Leme et al., 2018)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk

(Lubans et al., 2012)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
(Luesse et al., 2019)	n/a	n/a	High Risk	Low Risk	Low Risk
(Mendelson et al., 2015)	High Risk	High Risk	High Risk	Unclear Risk	Low Risk
(Quante et al., 2019)	n/a	n/a	Unclear Risk	Low Risk	Low Risk
(Robbins et al., 2016)	Low Risk	High Risk	Low Risk	Low Risk	Low Risk
(Pfeiffer et al., 2019)	Low Risk	High Risk	Low Risk	Low Risk	Low Risk
(Robinson et al., 2003)	n/a	n/a	Unclear Risk	Low Risk	Low Risk
(Romero, 2012)	n/a	n/a	Low Risk	Low Risk	Low Risk
(Roth et al., 2019)	Unclear Risk	Unclear Risk	High Risk	Low Risk	Low Risk
(Schleider et al., 2019)	Low Risk	Low Risk	Unclear Risk	Low Risk	Low Risk
(Sethi et al., 2013)	n/a	n/a	Low Risk	Low Risk	Low Risk
(Shinde et al., 2018)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
(Sibinga et al., 2013)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
(Smith et al., 2016)	Low Risk	Low Risk	Low Risk	Low Risk	Low Risk
(Vicary et al., 2004)	Unclear Risk	Unclear Risk	Unclear Risk	Low Risk	Low Risk

Intervention Characteristics

The intervention characteristics are detailed in table 4.3 below. The largest group of interventions focused on PA and diet (n = 13) (Aceves-Martins et al., 2017; Baker et al., 2012; Black et al., 2010; Dewar et al., 2013; Dubuy et al., 2014; Frenn et al., 2005; Frenn, Malin, & Bansal, 2003; Frenn, Malin, Bansal, et al., 2003; Holmberg et al., 2018; Issner et al., 2017; Jackson et al., 2010; Leme et al., 2018; Lubans et al., 2012), followed by PA (n = 8) (Bandeira et al., 2020; Casey et al., 2014; Fröberg et al., 2018; Hollis et al., 2016; Pfeiffer et al., 2019; Robbins et al., 2016; Romero, 2012; Roth et al., 2019; Smith et al., 2016) and mental health (n = 7) (Araya et al., 2013; Dray et al., 2017; Frazier et al., 2015; Mendelson et al., 2015; Schleider et al., 2019; Sethi et al., 2013; Shinde et al., 2018). The remainder targeted diet (n = 4) (Alaimo et al., 2015; Brito Beck da Silva et al., 2015; Knapp et al., 2019; Luesse et al., 2019); substance abuse (n = 2) (Vicary et al., 2004; Robinson, Harper, and Schoeny, 2003); PA, diet, substance abuse and mental health (Fardy et al., 1996); mental health and sleep (Sibinga et al., 2013);PA, diet and substance abuse (Kerr et al., 2013); Sleep (Quante et al., 2019); mental health and PA (Beaulac et al., 2011) and PA, diet and mental health (Berria et al., 2018). Interventions were delivered by a wide range of people. The duration of the interventions ranged from a single session (Issner et al., 2017) to a three-year program (Dray et al., 2017). Twenty of the interventions incorporated a behavioural theory into the design (Araya et al., 2013; Bandeira et al., 2020; Beaulac et al., 2011; Black et al., 2010; Casey et al., 2014; Dewar et al., 2013; Frenn et al., 2005; Frenn, Malin, & Bansal, 2003; Frenn, Malin, Bansal, et al., 2003; Hollis et al., 2016; Issner et al., 2017; Kerr et al., 2013; Leme et al., 2018; Lubans et al., 2012; Luesse et al., 2019; Pfeiffer et al., 2019; Robbins et al., 2016; Romero, 2012; Roth et al., 2019; Smith et al., 2016), with 12 of these underpinning their intervention strategies with multiple theories (Bandeira et al., 2020; Black et al., 2010;

Casey et al., 2014; Frenn et al., 2005; Frenn, Malin, & Bansal, 2003; Frenn, Malin, Bansal, et al., 2003; Hollis et al., 2016; Issner et al., 2017; Luesse et al., 2019; Pfeiffer et al., 2019; Robbins et al., 2016; Smith et al., 2016). Twenty-three of the 41 interventions did not measure implementation fidelity.

The majority of outcomes associated with the included interventions were concerned with health-related behaviours (Aceves-Martins et al., 2017; Alaimo et al., 2015; Bandeira et al., 2020; Brito Beck da Silva et al., 2015; Casey et al., 2014; Dubuy et al., 2014; Fardy et al., 1996; Frazier et al., 2015; Frenn, Malin, Bansal, et al., 2003; Frenn et al., 2005; Frenn, Malin, & Bansal, 2003; Fröberg et al., 2018; Issner et al., 2017; Jackson et al., 2010; Kerr et al., 2013; Luesse et al., 2019; Romero, 2012; Sibinga et al., 2013; Smith et al., 2016; Vicary et al., 2004; Robinson, Harper, & Schoeny, 2003). Other outcomes included; psychosocial function (Araya et al., 2013; Brito Beck da Silva et al., 2015; Casey et al., 2014; Dray et al., 2017; Dubuy et al., 2014; Frazier et al., 2015; Issner et al., 2017; Luesse et al., 2019; Mendelson et al., 2015; Schleider et al., 2019; Sethi et al., 2013; Sibinga et al., 2013; Vicary et al., 2004), health-related knowledge (Baker et al., 2012; Fardy et al., 1996; Jackson et al., 2010; Kerr et al., 2013; Vicary et al., 2004), physical measures (body composition, physical fitness and biochemical measures) (Black et al., 2010; Brito Beck da Silva et al., 2015; Dewar et al., 2013; Fardy et al., 1996; Leme et al., 2018; Lubans et al., 2012; Pfeiffer et al., 2019; Sibinga et al., 2013; Smith et al., 2016) and the cohort's evaluation of the intervention (Beaulac et al., 2011; Dubuy et al., 2014; Holmberg et al., 2018; Jackson et al., 2010; Knapp et al., 2019; Quante et al., 2019). The majority of studies used multi-component interventions (n = 30).

Intervention Results

In the interventions targeting both PA and diet, the behavioural outcomes reported were mixed. Five of the interventions improved both PA levels and dietary habits significantly (Frenn et al., 2005; Frenn, Malin, & Bansal, 2003; Issner et al., 2017; Jackson et al., 2010), whereas two observed no significant improvement in either behaviour (Dubuy et al., 2014; Frenn, Malin, Bansal, et al., 2003). In the interventions aiming to improve PA and nutrition knowledge, both were effective (no significance level reported) (Baker et al., 2012; Jackson et al., 2010). Interventions targeting changes in anthropometric measures, such as BMI and body composition, also showed mixed levels of effectiveness. One intervention did not improve any measure of anthropometry (Leme et al., 2018), while another significantly improved body fat percentage but not BMI (Dewar et al., 2013). Furthermore, one significantly improved the percentage of individuals who were overweight or obese but did not improve total fat percentage, fat mass or fat free mass of participants (Black et al., 2010), and finally Lubans et al., (2012) improved BMI and body fat percentage slightly, but not significantly. The two interventions targeting psychosocial correlates associated with PA and dietary habits resulted in significant improvements (Dubuy et al., 2014; Issner et al., 2017). Interventions which assessed the student's perception of the intervention, displayed positive responses (Holmberg et al., 2018; Issner et al., 2017).

In the interventions targeting PA only, five targeted behavioural outcomes (levels of PA). Four of which were unsuccessful in improving PA levels in their targeted cohorts (Casey et al., 2014; Fröberg et al., 2018; Roth et al., 2019; Smith et al., 2016), and one observed a significant improvement in girls but not in boys (Romero, 2012). Health related quality of life, however, was significantly improved in one of these interventions (Casey et al., 2014) and muscular fitness in another (Smith et al., 2016). Furthermore, interventions focused on reducing screen time did not observe any positive changes in behaviour (Bandeira et al., 2020). Interventions assessing anthropometric measures had higher levels of success, with one study reporting a significant reduction in weight and BMI among the intervention group (Hollis et al., 2016), while another observed a significant reduction in body fat percentage (Smith et al., 2016) and one observed modest positive changes in body fat percentage (Pfeiffer et al., 2019). An intervention assessing the dose, reach and fidelity reported positive findings on all three variables (Robbins et al., 2016). The majority of the mental health interventions targeted psychological functioning, with the authors reporting mixed levels of success. Depressive symptoms were measured in two interventions; one reporting a non-significant improvement (Schleider et al., 2019) and the other finding no intervention effects (Araya et al., 2013). In addition, Schleider et al., (2019) reported no improvement in social anxiety symptoms following the intervention. Similarly, Dray et al., (2017) found no significant differences between the control and intervention group's internalising problems, externalising problems and prosocial behaviour scores following the intervention. In a park-based intervention, results showed no significant improvements in parent-reported social skills or problem behaviours, however, staff-reported findings highlighted significant improvements in both problem behaviours and social skills at follow-up (Frazier et al., 2015). In other interventions targeting mental health; social, emotional and academic performance (Mendelson et al., 2015), attention and self-efficacy (Sethi et al., 2013), and school environment (Shinde et al., 2018) were significantly increased.

Interventions specifically targeting diet had varied levels of success. Three programs targeted dietary behaviours specifically. One intervention reported a significant increase in the intake of fruit and vegetables and a statistically insignificant decrease in highly processed foods, compared with baseline (Luesse et al., 2019). Significant increases, however, were seen in psychosocial mediators, and qualitative assessments suggest that the intervention promoted skill building, but environmental barriers made these difficult to use. The two other interventions targeting dietary behaviours reported significant improvements as a result of the interventions (Alaimo et al., 2015; Brito Beck da Silva et al., 2015). School nutrition practice and policy was also significantly improved in the intervention by Alaimo et al., (2015). Finally, one intervention aimed to measure the students', teachers' and parents' perceptions of the intervention, and to identify attributes that were highly valued (Knapp et al., 2019). Four key themes ((1) development of life skills, (2) food and health, (3) family and community, and (4) experiential and participatory learning environment) were identified, and all stakeholders positively appraised the intervention.

Both interventions solely targeting substance abuse aimed to improve behavioural outcomes. An intervention by Robinson, Harper, and Schoeny, (2003) targeting a reduction in cigarette smoking, alcohol consumption and marijuana use reported significant reductions in cigarette and marijuana use, but not in alcohol consumption. Vicary et al., (2004) reported mixed findings on cigarette use and alcohol consumption over the assessment time points in the two intervention groups. Similarly, measurements of skills related to substance abuse (decision making skills, refusal skills, media awareness and resistance skills) resulted in mixed findings.

A multi-health domain intervention which targeted PA, dietary habits, substance abuse and mental health (Fardy et al., 1996) resulted in significantly improved cardiovascular health knowledge scores in males and females. In females, dietary habits, total cholesterol and estimated the maximum rate of oxygen consumption (Vo2 Max) also significantly improved. All other risk factors were non-significant in males and females. A sleep intervention qualitatively assessed the acceptability of two mobile phone apps to improve sleep hygiene (Quante et al., 2019). The overall feedback on the application was positive, although several barriers were identified, and the students were skeptical about successfully adopting sleep hygiene practices. Furthermore, an intervention targeting both mental health and sleep significantly improved some psychological functioning measures (anxiety, negative coping approaches and self-reported anger) but not cortisol levels or sleep scores (Sibinga et al., 2013). An intervention targeting mental health and PA, which used qualitive analysis to understand the perceived impact of the intervention on youth participants, found that the program was a promising method to improve psychological, social and physical well-being (Beaulac et al., 2011). The adolescents, parents and program implementers described benefits across seven main areas, including dancing and related skills, behaviours (e.g., reduced television viewing), physical well-being, psychological well-being, relationships, respect for others and for diversity, and school performance. A PA, diet and mental health intervention assessed predictors to dropout in the 'Mexa Se' intervention (Berria et al., 2018). It was reported that in the intervention group age, body mass, height and BMI were all significant predictors of drop out. Finally, in the intervention implemented by Kerr et al., (2013), aimed at improving PA, diet and substance abuse, it was reported that general health knowledge scores increased significantly more in the intervention group compared to the control. Health behaviours, however, did not significantly differ between groups post-intervention.

Effective Intervention Strategies

'Hands-on' or Practical Learning

Of the interventions identified within the review, many adopted 'hands-on' or practical learning component); a strategy that proved effective across various health domains (to understand what constitutes hands-on or practical learning, see 'Definition of Key Terms' section in Chapter 1). For example, an intervention targeting social, emotional and academic function by Mendelson et al., (2015) incorporated mindfulness sessions into the program; resulting in significant improvements across all three health scores (social, emotional and academic function) post-intervention. Similarly, participants in an intervention by Sibinga et al., (2013), who practiced mindfulness and yoga within the intervention, reported significantly improved psychological functioning. Furthermore, in an intervention targeting dietary habits (Luesse et al., 2019), participants prepared and ate minimally processed meals with the objective of making these foods look 'cool and fun'. The intervention resulted in a large significant increase in the participants' consumption of minimally processed foods. Another example of practical learning was articulated in Jackson et al., (2010), where the students learned pertinent nutrition and PA information that was later incorporated into writing and performing their own "healthy" skits in a theatre-based program. This intervention resulted in improved knowledge around PA and dietary habits, improved health-related choices, and the students reported that the intervention was an enjoyable experience.

Peer Support

The use of peer support was another effective intervention strategy identified within this review. For example, a social marketing intervention by Aceves-Martins et al., (2017), which aimed to encourage adolescents to increase their fruit and vegetable intake, PA levels and reduce screen time, was led and designed by peer students (who were trained by university specialists). The social marketing intervention resulted in a significant increase in fruit intake, PA levels and a reduction in screen time after a 12-month intervention. Similarly, two interventions (Frenn, Malin, & Bansal, 2003; Frenn, Malin, Bansal, et al., 2003), also targeting dietary habits and PA levels, which used the

Transtheoretical Model to tailor intervention strategies and feedback suggestions to adolescents, also adopted a peer-led approach. Participants in the preparation, action and maintenance stages of change were used as peer models for students in the pre-contemplation and contemplation stages of change and led interventions sessions targeting healthy eating and exercise promotion with the assistance of nursing students. Both interventions produced findings supporting the peer-led approach; with one intervention reporting significant changes in dietary behaviour and PA in the intervention group compared to the control (Frenn, Malin, & Bansal, 2003), and the other reporting non-significant changes in dietary habits and significant changes in PA levels in the intervention group compared to the control (Frenn, Malin, Bansal, et al., 2003).

Holistic Approaches

Finally, this review identified the use of holistic approaches to school-based health interventions as an effective strategy. It has been suggested that for health interventions to be effective they should focus on more than just the educational component (Shackleton et al., 2016), with research stating that interventions should also target the school environment and engagement with families or communities (or both) (Langford et al., 2014). The benefit of adopting an intervention framework which targets all three areas is demonstrated by Hollis et al., (2016). The intervention, which incorporated teaching strategies to maximise PA and PE lessons (formal health curriculum); the development of school policies and PA lunch programs (school environment); and the development of a community PA expo and community newsletters (community links), reported significant improvements in the weight, BMI and PA (Sutherland et al., 2016) (these effects were reported in a paper outside of this review). Although no other interventions included in this review met all three of the criteria of the WHO HPS framework as comprehensively as Hollis et al., (2016), other interventions which targeted either the community/parent links, or the school environment, also reported successful findings. For example, the intervention presented in Casey et al., (2014), which was shown to significantly improve health related quality of life, implemented a PE component that was linked to a community component addressing previously reported barriers to PA participation. Furthermore, the pedagogical approach (student-centred teaching based on 'Game Sense' an Australian derivative of the Teaching Games for Understanding approach and Productive Pedagogies in Curriculum Development) of the PE program in this study (Casey et al., 2014) aligned with recent developments in the community sports club. Additionally, a park-based program targeting social emotional learning by engaging the parents through family sessions (supplementing the youth's sessions), developed specific strategies that the families could model and reinforce at home (Frazier et al., 2015), ultimately leading to significant improvements in the staff reported measures of problem behaviours and social skills in the adolescents cohort. Similarly, an intervention by Jackson et al., (2010), which was successful in improving PA and dietary knowledge and behaviours (although no significance was reported), involved the parents by hosting healthy eating recipe sessions, completing home-based intervention sessions and inviting the parents to a performance by the adolescents where pertinent dietary or PA information was translated into a theatrical performance. Finally, an intervention by Alaimo et al., (2015), involved the assembly of a 'Coordinated School Health Team' (CSHT) to improve school nutrition and practices and policies. The CSHT, which was made up of representatives from various sectors of the school (including students), met to discuss school nutrition policies, nutrition environment, health education programs and school food service programs. Intervention schools adopted significantly more nutrition policies and practices than schools in the control group. In addition, students from the intervention schools consumed significantly more fruit and fibre, and less cholesterol than students from the control schools.

Table 4.3. Intervention Characteristics

	Author	Purpose of the Intervention	Key Features of the Intervention	Deliver-ed by	Duration	Theory	Study Outcome(s) Measured	Effectiveness (in relation to the outcome measures)	Fidelity Measure
Diet and PA Interventions (n=13)									
	(Aceves-Martins et al., 2017)	To increase fruit and vegetable intake and PA, while reducing screen time	(a) Adolescent challenge creator (ACC) training: An initial training session on social media principles and healthy lifestyle theory led by a university specialist in health and communication (b) Design and implementation of 10 activities: ACCs attended activity design sessions. The themes of the activities were based on the primary and secondary objectives of the	ACCs, (trained by university specialists)	12 months	None reported	Fruit and vegetables intake Weekly moderate to vigorous PA (MVPA) Sedentary time (questionnaires)	The percentage of adolescents in the intervention group who consumed ≥1 portion of fruit/day increased by 23.5% ($p < 0.01$), Vegetable consumption differed only in males. The percentage of males consuming ≥1 portion of vegetables/day increased by 27.9% ($p < 0.01$) in the intervention group. The percentage of adolescents in the intervention group who engaged in ≥6 hours of PA/week participation increased by 21.2%	No

			study, which would stimulate the interest of their peers and were designed to be attractive. The ACCs presented the intervention in classrooms at the two intervention schools, in which they explained the study, provided social media information, and invited their peers to provide suggestions for activities. The ACCs disseminated the activities using social media platforms, posters and flyers. Information, photographs, and videos pertaining to each activity were uploaded to the campaign's social media platforms. Number of participants = 170					($p < 0.01$). The percentage of male adolescents who engaged in ≤2 hours of screen time/week increased by 27.9% ($p < 0.01$) in the intervention group and 12.3% in the control group ($p = 0.01$).	

	(Baker et al., 2012)	To promote a healthy lifestyle and improve healthy behaviours * (oral hygiene, hand washing techniques, PA, personal hygiene, and nutrition and food safety) *information reported	Medical students presented a lecture, followed by an exercise session (circuit training), healthy smoothie preparation, and nutritional value of food analysis. The lecture topics were broken down into modules (Physical Health and Healthy Eating Habits), and included: methods for achieving optimal fitness, types of exercise, proper weight gaining/loss techniques and nutrition/food safety. The intervention was linked to the NFL Youth Education Town community centre. Number of participants = 46	Medical students	5 weeks	None reported	Awareness and knowledge about exercise and healthy lifestyles Demonstration of effective ways to exercise and maintain health Awareness and knowledge of proper food handling and better eating habits	Physical Health Module: 17% of the participants passed the pre-test (60% or higher). 67% percent of all participants passed their post-test (60% or higher, achieving that objective). 75% of these participants improved their test scores by at least 10%, also achieving that objective. Following the end of the intervention program, the survey showed a positive change in behaviour in 75% of the participants Healthy Eating Habits Module: 29% of the participants passed the pre-test (60% or higher). 50% of the participants passed the post-test (60% or higher), failing to achieve that objective.	No

		in this review relates to PA and nutrition components					Demonstration of ways to determine the proper nutritional values of foods (questionnaires)	86% of all the participants improved their scores by at least 10%, successfully achieving that objective. The survey following the intervention showed that 50% of the participants positively changed their personal eating habits.	
	(Black et al., 2010)	Health promotion and obesity prevention program	A manualized 12-session intervention ("Challenge") included: a rap music video promoting healthy eating and PA principles of mentorship (role modelling and support), participatory learning, goal setting. In addition to setting dietary and PA goals, tracking and evaluating progress, and revising goals as necessary,	Specially trained, college-enrolled, African American mentors	(Approx.) 10 months	Social Cognitive Theory and Motivational Interviewing	The accretion of body mass (BMI) and body fat % (DEXA)	The percentage of overweight/obese adolescents declined from 54% to 36% in the intervention group while the percentage declined from 36% to 32% among the control group. The percentage overweight/obese adolescents further declined to 35% in the intervention group, but increased to 38% among the control group at delayed follow-	No

			intervention adolescents prepared and tasted healthy snacks and engaged in PA, Number of participants = 121					up, resulting in a significant difference between groups ($\chi 2$=5.8, p=0.02, GEE). There were no statistically significant interactions between intervention and time in either post-intervention or delayed follow-up for total percent body fat, fat mass or fat free mass in the multi-level modelling with the whole sample.	
	(Dewar et al., 2013)	To promote PA and healthy eating and prevent obesity among inactive adolescent girls	The Nutrition and Enjoyable Activity for Teen (NEAT) Girls combined a range of strategies to promote lifestyle (e.g., walking to school) and lifetime PA (e.g., resistance training), improve dietary intake, and reduce sedentary behaviours.	Teachers, researchers, dieticians	12 months	Social Cognitive Theory	BMI	There were no changes in BMI, but there was a group-by-time interaction effect for percentage body fat (–1.96%, p=0.006)	Yes

			Intervention components included: enhanced school sport sessions and lunchtime PA, nutrition workshops, interactive educational seminars, pedometers for self-monitoring, student handbooks, parent newsletters, text messages to reinforce and encourage health behaviours. Number of participants = 179						
	(Dubuy et al., 2014)	To promote a healthy diet and PA	3 components (Start clinic, school program, end clinic). Clinics (ran by players): eating healthy breakfast, warm up session with players and signing a lifestyle contract. School element: providing free fruit to all pupils, fruit &	Professional soccer players, health workers and teachers	4 months	None reported	PA levels Dietary habits Psychosocial correlates Students evaluation of the intervention	No intervention effects were found for consumption of breakfast, fruit, soft drinks or sweet and savoury snacks. Positive intervention effects were found for self-efficacy for having a daily breakfast ($p < 0.01$), positive attitude towards vegetables consumption ($p < 0.01$)	Yes

			vegetable quiz, lessons on importance of drinking enough water, activity breaks and active playgrounds. Number of participants = 268				(questionnaires)	and towards lower soft drink consumption ($p < 0.001$). A trend towards significance ($p < 0.10$) was found for self-efficacy for reaching the PA guidelines. For sports participation, no significant intervention effect was found. 92 students completed the process evaluation questionnaire, the feedback was largely positive.	
	(Frenn, Malin, & Bansal, 2003)	To improve the adoption of a diet lower in fat and duration of PA	The primary classroom strategy for the sessions was consciousness raising and self-re-evaluation Separate smaller group sessions were held for students in the preparation, action, and maintenance	Paediatric nursing students	4 classroom intervention sessions (Duration of	Transtheoretical Model and Health Promotion model	Dietary fat intake (questionnaire) PA duration (PA log)	When the Health Promotion/Transtheoretical Model interventions were used in 4 classroom sessions, students had a significantly ($p <.05$) reduced trend toward choosing a diet higher in fat and increased	No

			stages of change Examples of content used include food pyramids, food diaries, peer leadership, planning exercise sessions (Specific strategies detailed in the paper) Number of participants = 60		intervention not reported)			duration of PA, as compared with a control group	
	(Frenn, Malin, Bansal, et al., 2003)	To examine improvement related to Healthy People 2010 Objectives (U.S. Department of Health & Human Services, 2000) for	Internet and video sessions for students in precontemplation and contemplation stages of change focused on raising awareness of current eating and exercise, identifying pros (or benefits) of both low-fat diet and exercise, and overcoming cons (or barriers) to consuming low fat diets and participating in exercise. Those in precontemplation, action, and maintenance	Peer models (students), nursing students and other faculty members	Academic year	Transtheoretical Model and Health Promotion model	Dietary fat intake (questionnaire) Weekly MVPA (PA log)	The difference in percentage of dietary fat intake between the intervention and control groups as a whole was not significant. Both control and intervention groups decreased their amount of MVPA, but the level of decrease in MVPA was less among the intervention group (–8.58 min) as compared to the control (–37.61 min; $p = .024$)	No

		low fat diet and MVPA	stages of change were prepared as "peer models" and led the healthy snack and exercise labs with the assistance of senior nursing students and faculty. Online feedback was given to all students in the intervention for each Internet session. (Specific strategies detailed in the paper) Number of participants = 67						
	(Frenn et al., 2005)	To increase PA and reduce dietary fat among low-income, culturally diverse,	Eight-session Blackboard platform-delivered internet approach with four 2- to 3-min videos. Sessions included: preparing snacks, raising awareness for food early in the day/nighttime binging, consciousness raising for PA	Blackboard platform delivery (internet and computer based)	1 month	Transtheoretical Model and Health Promotion Model	PA levels (PA log) Dietary fat intake (questionnaire)	Intervention students who completed more than half of sessions increased MVPA by an average of 22 min, compared with a decrease of 46 min for the control group, t (103) = −1.99, p = .05. Those who completed all three sessions increased PA by 33 min.	None reported

		seventh-grade students	and caloric balance Computer-generated tailored feedback based on stage of behaviour change was provided to individual subjects for both PA and dietary fat. (Specific strategies detailed in the paper) Number of participants = 43	Previously delivered by paediatric nursing students				Those participating more than half the sessions decreased percentage of dietary fat from 30.7 to 29.9, t (87) = 2.73, p = .008, whereas those in the control had 31.5% dietary fat in pre-test and 31.6% in post-test. Those participating in less than half the diet sessions were not significantly different than students in the control group classes, t (16.6) = −1.843, p = .08.	
	(Holmberg et al., 2018)	To improve MVPA, sedentary time, exercise training frequency and duration	The intervention was developed and implemented, as a result of cooperation and shared decision making among the researchers and the participants. Components included: health coaching, health-promotion sessions and a closed Facebook-group.	PhD students and the research team	2 years	None reported	The adolescents' experiences of participating in a health-promoting school-based intervention regarding	The adolescents appreciated influencing the components of the intervention and collaborating with peers in active learning activities such as practicing sports and preparing meals. They also reported acquiring new health information, that trying new activities was inspiring, and the use of pedometers and photo-food	No

			Number of participants = 49				food and PA, with a focus on empowerment (focus groups)	diaries helped them reflect on their health behaviours. This was echoed by teachers.	
Yes	(Issner et al., 2017)	To motivate urban, minority youth to make healthy changes in diet and PA	All participants engaged in goal discussion with a health coach that lasted 3–5 min. The enhanced intervention group continued the intervention after the goalsetting portion wherein facilitators used probes to discuss previous experience, elicit positive change talk, discussion of benefits, and ideas for potential solutions. Number of participants = 51	"Health coaches" (first and second author and Research Assistants)	20 minutes - 1 session	Self-Determination Theory and Motivational Interviewing	PA levels Fruit and vegetable intake Autonomous motivation and self-efficacy with an aim to improving healthy behaviours (questionnaires)	There was no significant interaction between the impact of the two intervention conditions on participants' reports of fruit and vegetable intake across two time periods Wilks Lambda = 1.00, F(2, 52) = .19, p = .66, partial eta squared = .004. A main effect of time trended toward significance, Wilks Lambda = .95, F(2, 52) = 2.88, p = .09, partial eta squared = .054, with both groups showing an increase in fruit and vegetable intake.	Yes

								There was no significant interaction between participants' reports of PA across two time periods, Wilks Lambda = .99, $F(2, 49) = .58$, $p = .45$, partial eta squared = .012. Time significantly affected outcomes, Wilks Lambda = .90, $F(2, 49) = 4.99$, $p = .03$, partial eta squared = .096, with both groups showing an increase in PA at time 2. In the goals only condition, from baseline to follow-up, PA significantly increased, $t(22) = -2.27$, $p < .05$ (effect size $d = .46$) and autonomous motivation for PA significantly increased, $t(22) = -2.45$, $p < .05$ (effect size $d = .56$). In the enhanced intervention condition, from baseline to	

								follow-up, PA significantly increased, $t(22) = -2.17$, $p < .05$ (effect size $d = .40$), autonomous motivation for diet significantly increased, $t(22) = -3.59$, $p < .001$ (effect size $d = .67$), and self-efficacy for diet significantly increased $t(22) = -3.91$, $p < .001$ (effect size $d = .67$).	
	(Jackson et al., 2010)	To engage low-income, urban, African American adolescents and their families in learning ways to	Interventions components included: nutrition and PA information education, preparation and performance of their own “healthy” skits, team building exercises designed to introduce theatre dynamics, which progressed into script writing activities, making healthy recipes or snacks.	Registered dietitian with a background in theatre and a program assistant	6 weeks	None reported	Food and PA knowledge (questionnaire) Food and PA choices and behaviour (questionnaire) The students experience of	Increases in the number of participants who knew the daily recommended number of servings of fruits and vegetables as well as the recommended amount of time healthy children should be active. When given a choice between specific food item and activity pairs, participants chose healthier food items and PA over sedentary activity at post-test.	No

		adopt a healthy lifestyle	Each session ended with some form of PA (circuit training or a dance routine). At the end of the 6-week program, students performed ‘Getting on Track’ for family and friends. Parents were engaged in three ways (1) participating in a health information and recipe session, (2) completing home-based activities (3) attending the intervention’s culminating event, the Champions of Health Dinner Theatre. Number of participants = 15				the intervention (focus groups)	An increase in students who responded “sometimes” when asked about healthy behaviour (eating fruits and vegetables instead of sweets and participating in PA instead of watching television) The participants experience of the intervention was positive and identified methods to improve future interventions.	
	(Leme et al., 2018)	To help achieve healthy food choices, promote	Intervention components included: enhanced PE classes, PA leadership book, recess PA, weekly nutrition and PA messages delivered by teachers during recess, three	Dieticians and teachers	6 months	Social-Cognitive Theory	BMI	No significant effect for BMI ($F = 2.120$, $p = 0.135$)	Yes

		lifestyle and lifetime PA, and reduce screen-time activities	interactive seminars led by dietitians, nutrition and PA handbook, nutrition workshops, dietary and PA diaries, parents' newsletters, text messages to students twice a week to encourage them to be physically active and eat healthily. Number of participants = 142						
	(Lubans et al., 2012)	To promote PA and healthy eating and prevent obesity among inactive adolescent girls	The Nutrition and Enjoyable Activity for Teen (NEAT) Girls combined a range of strategies to promote lifestyle (e.g., walking to school) and lifetime PA (e.g., resistance training), improve dietary intake, and reduce sedentary behaviours. Intervention components included: enhanced school	Teachers, researchers, dieticians	12 months	Social Cognitive Theory	BMI Body fat % (bioelectrical impedance analyser)	After 12 months, changes in BMI (adjusted mean difference, −0.19; 95% CI, −0.70 to 0.33), BMI z score (mean, −0.08; 95% CI, −0.20 to 0.04), and body fat percentage (mean, −1.09; 95% CI, −2.88 to 0.70) were in favour of the intervention, but they were not statistically different from those in the control group.	Yes

			sport sessions and lunchtime PA, nutrition workshops, interactive educational seminars, pedometers for self-monitoring, student handbooks, parent newsletters, text messages to reinforce and encourage health behaviours. Number of participants = 179						
PA (only) Interventions (n=9)									
	(Bandeira et al., 2020)	To promote PA and reduce the screen time	Teacher training, which was focused on lifestyle behaviours, including excessive screen time, and its implications for health support material, was delivered to teachers to assist them in organizing classes on the topic. Component opportunities were created to	Teachers and school staff, undergraduate PE students	4 months (one semester)	Socio-ecological Model, Health Promoting Schools and Social	Screen time (questionnaire)	There were no significant differences between intervention and control groups for reduction on screen time, in both sexes (boys: 0.105 h/day, 95% CI: −0.184 to 0.393,p = 0.477; girls: −0.065 h/day, 95% CI: −0.383 to 0.252, p = 0.686) and age groups (11–13 years: −0.046 h/day, 95% CI: −0.630 to0.538, p = 0.878;	Yes

			encourage PA and decrease screen time in the school environment so that adolescents could play games/sports during free time at school. Supervised sessions of 10–15 mins (“Gymnastics at School”) were performed twice a week. Health education messages were spread across the schools, and pamphlets were handed over to students/parents. The messages were also addressed to the psychosocial (self-efficacy, attitude, and social support) and environmental aspects of the practice of PA and reducing sedentary behaviour, especially screen time			Cognitive Theory		14–17 years: 0.193 h/day, 95% CI: −0.077 to 0.464,p = 0.162)	

			Number of participants = 548						
	(Casey et al., 2014)	To improve Health-Related Quality of Life (HRQoL), levels of PA, and a range of potential mediators of PA (e.g., self-efficacy, perceived sport competence).	School PE component which incorporated student-centered teaching approaches and behavioural skill development. The PE component involved students participating in two 6-session units, each designed as one session per week during their ‘normal’ PE class time. The two units were a sport unit (tennis or football) and a recreational unit. The curriculum and teaching approach drew on the principles of Game Sense, an Australian derivative of the Teaching Games for	PE teachers, community fitness instructors and sports coaches	One academic year	Socio-Ecological Model and Social Cognitive Theory	HRQoL PA levels (questionnaires)	After adjustment for baseline levels of PedsQL, the intervention group had significantly higher scores on all three PedsQL scores: physical functioning (adjusted M ± SE = 83.9 ± 0.7, p = .005), psychosocial (79.9 ± 0.8, p = .001) and total score (81.3 ± 0.7, p = .001) – than the control group (80.9 ± 0.8; 76.1 ± 0.9 and 77.8 ± 0.8 respectively), suggesting that the program positively influenced HRQoL. Differences in PedsQL were also present in the 3-group analysis (intervention completers, intervention non-completers and control), whereby the intervention	Yes

			Understanding approach, and productive pedagogies in curriculum development. Number of participants = 362					non-completers had significantly higher scores (84.0 ± 0.8, p = .021; 80.4 ± 0.9, p = .003; and 81.7 ± 0.8, p = .002 respectively) than the control group (80.9 ± 0.8, 76.1 ± 0.9 and 77.8 ± 0.8 respectively). There was no statistically significant difference in either the 2-group or 3-group analysis for mins of leisure time (LT) MVPA, MET-mins of LTMVPA, or in the proportion meeting PA guidelines.	
	(Fröberg et al., 2018)	To improve MVPA, sedentary time, exercise training frequency	The intervention was developed and implemented as a result of cooperation and shared decision making among the researchers and the participants. Components included: health coaching, health-promotion	PhD students	2 years	None reported	MVPA (accelerometer) Sedentary time (accelerometer)	There were no significant effects on changes in the accelerometer-measured MVPA (β = 0.26, 95% CI = [0.08; 0.43]) and sedentary time (β = −0.19, 95% CI = [−0.55; 0.15]), or the self-reported ET frequency (β = 0.03, 95% CI = [−0.25; 0.33]) and duration (β =	No

		and duration	sessions and a closed Facebook-group. Number of participants = 54				Exercise training (ET) frequency and duration (questionnaire)	0.27 [95% CI = 0.01;0.60]), among the adolescents	
	(Hollis et al., 2016)	To reduce the decline in PA typically observed during adolescence	The intervention components targeted the school curriculum, school environment, and broader community and parental support. School Curriculum included: Teaching strategies to maximise student PA in health and PE lessons, development and monitoring of student PA plans within PE lessons and the implementation of a 10-week enhanced school sports programme.	Teachers	19-24 months (7-9 school terms)	Social-Cognitive Theory and Socio-Ecological Model	Weight (BMI)/ BMI z-score Whether any effect was moderated by sex, baseline BMI and baseline PA (accelerometer)	At 12 months, there were group-by-time effects for weight (mean difference (95% CI) =−0.90 kg (−1.50; −0.30), P<0.01) and BMI (−0.28 kg m−2 (−0.50; −0.06), P=0.01) in favour of the intervention group, but not for BMI z-score (−0.05 (−0.11; 0.01), P=0.13). These findings were consistent for weight (−0.62 kg (−1.21; −0.03), P=0.01) and BMI (−0.28 kg m−2 (−0.49; −0.06), P=0.01) at 24 months, with group-by-time effects also found for BMI z-score (−0.08 (−0.14;	Yes

			School Environment included: The development and modification of school policies, PA programmes during school breaks and promotion of community PA providers. Additional interventions strategies included: an in-school PA consultant 1 day per week, establishing leadership and support, teacher training resources, teacher prompts and intervention implementation performance feedback to schools. Parent engagement: information was regularly sent to the parents via school newsletters, the school					−0.02), P=0.02) favouring the intervention group. Intervention effects were significant for all adiposity outcomes at 12 and 24 months in both the complete cases and multiple imputation analyses. There was weak evidence of a differential treatment on effect on weight in males compared with females (three-way interaction P=0.22). Among males there was a statistically significant treatment effect at 24 months in favour of the intervention group (−1.26 kg (−2.11; −0.41), P=0.01). There were no significant effects on weight, BMI and BMI z-score at either 12 or 24 months for females.	

			website and newsletters on PA recommendations, school-based PA strategies, promotion of community PA providers and strategies to support their child's PA. Number of participants = 645					There was weak evidence of a differential treatment on effect on weight in males compared with females (three-way interaction P=0.22). Among males there was a statistically significant treatment effect at 24 months in favour of the intervention group (−1.26 kg (−2.11; −0.41), P=0.01). There were no significant effects on weight, BMI and BMI z-score at either 12 or 24 months for females. Weight status at baseline: minimal evidence of differential treatment effects depending on baseline weight for weight (P=0.50), BMI (P=0.57) or BMI z-score (P=0.64). PA level at baseline: no evidence of differential treatment effects	

								depending on activity status at baseline for weight (P=0.94), BMI (P=0.95) or BMI z-score (P=0.31). There was no significant effect on weight, BMI or BMI z-score for either active or inactive students at 12 or 24 months.	
	(Robbins et al., 2016)	To facilitate long-term attainment of adequate MVPA by enhancing girls' perceptions of perceived benefits,	A 90-minute PA club included: Organisational tasks (recording attendance and putting equipment away), healthy snacks, warm up activities, encouragement of MVPA, incorporation of information from the Health Promotion Model and Self-Determination Theory and varying forms of PA. Number of participants = 752	PA club manager and 3–4 PA club instructors	17 weeks	Health Promotion Model and Self-Determination Theory	Dose (accelerometer and observation) Reach (attendance) Fidelity (questionnaire)	Reach: Across the 3 years, the total mean attendance at the PA club was 20.54 ± 16.50 days, equivalent to 41 % attendance. 93 evaluations were used to measure Dose Dose Received (exposure): the mean accelerometer measured MVPA time was 21.85 ± 6.16 min, and the average number of steps was 2826 ± 820.	Yes

		self-efficacy, enjoyment, social support, role models, autonomy, relatedness, competence and reducing barriers relative to PA						Dose Received (satisfaction): 88 of the 93 (95.7 %) observations by the process evaluators indicated that the girls liked the PAs conducted in the club, and all agreed that girls liked their club instructors. 451 girls completed the satisfaction questionnaire after the 17-week intervention. On average, 87.8 % (n = 396) liked the activities offered in the club, and 85.4 % (n = 385) liked the club coaches/managers. Fidelity: process evaluators perceived that the PA club was well received by the girls and delivered with high quality by the coaches/managers. In addition, girls perceived the club was successful in increasing their PA.	

	(Pfeiffer et al., 2019)	To facilitate long-term attainment of adequate MVPA by enhancing girls' perceptions of perceived benefits, self-efficacy, enjoyment, social support, role models, autonomy, relatedness,	A 90-minute PA club included: Organisational tasks (recording attendance and putting equipment away), healthy snacks, warm up activities, encouragement of MVPA, incorporation of information from the Health Promotion Model and Self-Determination Theory and varying forms of PA. Number of participants = 752	PA club manager and 3–4 PA club instructors	17 weeks	Health Promotion Model and Self-Determination Theory	BMI z-scores Body fat % (bioelectrical impedance analyser) Aerobic performance (Vo2max)	No significant between-group differences in BMI-z existed at post-intervention, but % body fat increased less among intervention than control group girls (Mchange= 0.43% vs. 0.73%). Aerobic performance decreased less in intervention vs. control (Mchange= −.39 vs. −.57).	Yes

		competence and reducing barriers relative to PA							
	(Romero, 2012)	To increase frequency of vigorous PA	The first 20 minutes of lessons were interactive sessions focused on lesson content followed by 30-minute break dancing sessions. Lessons were created in collaboration with key stakeholders (middle school students, middle school teachers, health educators, and local break dancers). Key components of the intervention were based on Social Cognitive Theory and included the following: self-efficacy, culturally similar	Bilingual/bicultural female university students	5 weeks	Social Cognitive Theory	Vigorous PA Dance frequency (questionnaire)	For girls, a significant increase in vigorous exercise was found from pre-test to post-test, but this was not significant for boys. No significant differences were found in dance frequency.	No

			social role models, positive specific feedback on behaviour by teachers and peers, regular logs of PA, setting measurable goals, and identifying neighbourhood resources for PA. Number of participants = 71						
	(Roth et al., 2019)	Predisposing, enabling, and reinforcing factors for PA as well as self-reported PA	Intervention schools were provided a middle school PE curriculum, $2,500 in equipment vouchers for use in PE classes, and a $200 stipend for completing all 12 hours of the training. Number of participants = 3763	PE teachers	2 years	Social Learning Theory	Daily PA Muscle-strengthening PA (questionnaire)	While there were no detectable intervention effects on daily PA, there was a negative intervention effect detected for weekly muscle strengthening PA.	No
	(Smith et al., 2016)	To examine the mediating effect of	Intervention components included: researcher-led seminars for students, provision of fitness equipment	Teachers	20 weeks	Self-Determination Theory	Body fat % (bioelectrical impedance analyser)	The mediated effect was statistically significant for percentage of body fat (B [SE] = −.95 [.26]; 95% CI = −1.49 to	Yes

		resistance training skill competency on percentage of body fat, muscular fitness and PA	to schools, smartphone application and website, pedometers for self-monitoring, parental strategies for reducing screen-time (i.e., newsletters), lunch-time PA mentoring sessions and face-to-face activity sessions run by teachers during the timetabled school sport period. Number of participants = 181			and Social Cognitive Theory	Muscular fitness (hand grip and push-up tests) MVPA (accelerometer)	−.47) and muscular fitness (B [SE] = .16 [.07]; 95%CI = .03 to .31). The mediated effect was not significant for MVPA (B [SE] = .50 [2.1]; 95%CI = −3.6 to 4.6).	
Mental Health Interventions (n=7)									
	(Araya et al., 2013)	To reduce depressive symptoms among low-income	The intervention consisted of 11 weekly and 2 booster sessions, each lasting approximately 1 hour. There was an introductory session, 6 sessions dealing with thought restructuring and emotions, 3 sessions of problem solving strategies, and 1 closing	Psychologists, occupational therapists, and social workers)	3 months	Cognitive Behavioural Model	Depressive symptoms (questionnaire)	There was no evidence of any clinically important differences between the intervention and control arms in depressive symptoms scores at 3 months (adjusted difference in means, −0.19; 95% CI, −1.22 to 0.84; P = .72) or at 12 months.	Yes

		secondary school students	session to revise and integrate all previous work. Two booster sessions delivered at months 2 and 7 reviewed challenging negative thoughts and problem solving strategies. Number of participants = 1221					The adjusted difference in the primary outcome at 3 months between trial arms was −0.15 (95% CI, −1.12 to 0.81; P = .75) with 20 imputed full data sets.	
	(Dray et al., 2017)	To increase the provision of universal strategies targeting multiple internal and external resilience	A framework of sixteen intervention strategies. Each strategy was designed to address one or more internal or external resilience protective factor. Intervention schools were asked to meet the prescribed set of strategies; however, schools were given the flexibility to select which specific programs or resources to implement to address each of the strategies. (The 16 strategies are detailed in the paper)	Teachers	3 years	None reported	Total Strengths and Difficulties Questionnaire (SDQ) score Internalising problems Externalising problems Prosocial behaviour (questionnaires)	There was no significant difference between intervention and control groups for the outcomes of total SDQ, internalising problems and prosocial behaviour There was a significant difference for the outcome of externalising problems in favour of the control group, though the magnitude of effect was small (b¼0.43, 95% CI: 0.04 to 0.83,p¼0.02)	Yes

		protective factors	Number of participants = 1909						
	(Frazier et al., 2015)	To leverage recreational activities for social emotional learning	Leaders @ play: The program included didactic instruction, skills demonstration and discussion, role plays, and sports and recreation to provide practice with feedback. The first two sessions included team building activities; introduction to the Good Behaviour Game; and orientation to the junior camp counsellor internship. Intervention content emphasized social problem solving, emotion regulation, and effective communication. The last two sessions included review, celebration, and preparation for summer camp.	Physical instructor, park recreation leaders, park supervisors, mental health providers	Leaders @ play = 10 weeks. Parents @ play = 10 weeks	None reported	Social skills Problem behaviour (questionnaire)	There were no significant changes in parent report of Social Skills over time: baseline to post-test: $t_{62} = -0.23$, n.s., post-test to follow-up: $t_{50} = 1.19$, n.s, and baseline to follow-up: $t_{64} = 1.08$, n.s. Despite a trended increase in parent-reported Problem Behaviours from baseline to post-test, $t_{65} = -1.84$, $p = 0.56$ (Cohen's $d = -0.46$), these ratings returned to baseline levels by follow-up, $t_{50} = 1.83$, $p = .07$ (post-test to follow-up) and $t_{65} = 0.26$, n.s. (baseline to follow-up). Staff-reported Problem Behaviours for the total sample	Yes

			Families @ Play: Multi-family groups comprised of youth, parents, and extended family were designed to meet twice per month for 90 min. The format and content mirrored those of Leaders @ Play. The primary goal was to introduce a targeted skill (problem solving , emotion regulation, or effective communication), accompanied by specific strategies by which families could model and reinforce them at home Number of participants = 46					across sites showed no change from baseline to post-test, $t\ 49 = 1.64$, n.s., but declined significantly by follow-up, $t\ 61 = 2.04$, $p < 0.05$ (post-test to follow-up) and $t\ 60 = 3.75$, $p < 0.0001$ (baseline to follow-up). Staff-reported Social Skills improved from baseline to post-test, $t\ 51 = -2.56$, $p = 0.01$ and follow-up, $t\ 63 = -2.11$, $p < 0.05$, and gains were maintained from post-test to follow-up, $t\ 62 = 1.49$, n.s. Effect sizes based on overall means from the total sample showed staff-reported reductions in Problem Behaviours ($d = 0.46$ at post-test and 0.88 at follow-up) and gains in Social Skills ($d = -0.72$ and -0.53, respectively).	

	(Mendelson et al., 2015)	To enhance social, emotional, and academic functioning	RAP Club incorporates psychoeducation, cognitive behavioural, and mindfulness strategies from three evidence-supported treatments: Dialectical Behaviour Therapy for Adolescents, Trauma Adaptive Recovery Group Education and Therapy and School-Based Trauma/Grief Group Psychotherapy Number of participants = 29	Co-facilitated by a mental health counsellor and young adult community member	6 weeks	None reported	Social, emotional, and academic functioning (questionnaire)	Compared with controls, intervention students improved on teacher rated dysregulation ($F(1,43)=7.94$, $p < 0.01$, $d=0.85$), social competence ($F(1,43)=8.32$, $p<0.01$, $d=0.87$), academic competence ($F(1,45)=6.65$, $p<0.05$, $d=0.76$), and authority acceptance ($F(1,43)=5.43$, $p<0.05$, $d=0.69$). The pattern of scores was in the predicted direction for all the other teacher-reported outcomes, except attention. Student-reported outcomes did not differ by study condition. 17% of intervention students had elevated baseline depression; all displayed a pattern of reduced post-test symptoms. 83% of intervention participants reported low baseline depression;	No

								compared with control participants with low baseline depression, these students showed improved teacher-rated dysregulation ($t(39)=2.9$, $p<0.01$), social competence ($t(38)=-2.57$, $p<0.05$), academic competence ($t(40)=-2.27$, $p<0.05$), authority acceptance ($t(39)=2.53$, $p<0.05$), and disciplinary sanctions (($t(39)=2.28$, $p<0.05$) Higher program dose was associated with greater improvement than low dose on teacher-rated academic comparison ($t(1,25)=2.93$, $p<0.01$), discipline ($t(1,25)=2.24$, $p<0.05$), and conduct problems ($t(1,25)=2.4$, $p<0.05$).	

	(Schleider et al., 2019)	To reduce depressive symptoms, social anxiety symptoms, and conduct problems	Growing Minds (GM): a self-administered, computerized single session intervention (SSI), which includes content related to multiple types of mind-sets (personality, intelligence, self-regulation) across four interactive modules. Number of participants = 115	Self-administered on a computer. Research assistance was available for assistance if needed	1 session	None reported	Depressive symptoms Social anxiety symptoms Conduct problems (questionnaires)	Relative to girls in the control group, girls receiving the GM-SSI reported modest but significantly greater reductions in depressive symptoms (d=.23) and likelihood of reporting elevated depressive symptoms (d=.29) from baseline to follow-up. GM-SSI effects were nonsignificant for social anxiety symptoms, although a small effect size emerged in the hypothesized direction (d=.21), and nonsignificant for change in conduct problems (d=.01).	No
	(Sethi et al., 2013)	To improve attention	All the students participated in the yoga course for 5 days. The module was selected from	Not reported	5 days	None reported	Attention (Rosenberg self-esteem scale)	The intervention resulted in a significant increase in self-efficacy ($P = 0.001$) and attention scores ($P < 0.001$).	No

		and self-efficacy	Integrated Approach of Yoga Therapy for positive health. Number of participants = 60				Self-efficacy (d2 test)		
	(Shinde et al., 2018)	To improve school climate and health-related outcomes	The intervention identifies four priority areas for action: promoting social skills among adolescents; engaging the school community in school-level decision making processes; providing access to factual knowledge about health and risk behaviours to the school community; and enhancing problem solving skills among adolescents. The intervention strategies were organised at three levels: whole school, group, and individual levels, and include: School health committee, awareness generation fun	Lay counsellor (SM) or Teacher (TSM)	One academic year	None reported	School climate (questionnaire)	Participants in the SM-delivered intervention schools had substantially higher school climate scores at endpoint survey than those in the control group (BBSCQ baseline-adjusted mean difference [aMD] 7·57 [95% CI 6·11-9·03]; effect size 1·88 [95% CI 1·44-2·32], p<0·0001) and the TSM-delivered intervention (aMD 7·57 [95% CI 6·06-9·08]; effect size 1·88 [95% CI 1·43-2·34], p<0·0001). There was no effect of the TSM-delivered intervention compared with control (aMD -0·009 [95% CI -1·53 to 1·51], effect size 0·00 [95% CI -0·45 to 0·44], p=0·99).	Yes

			activities, speak out box (letterbox), wall magazine, competitions (debates, poster making, quizzes etc.), health policies, peer groups, workshops, individual counselling. Number of participants in the teacher led intervention = 4046 Number of participants in the lay counsellor led intervention = 4524						
Diet Interventions (n=4)									
	(Luesse et al., 2019)	To increase intake of whole/ minimally processed	In ’Defence of Food’ is a health education curriculum of 10 sequential 2-hour educational lessons. The lessons were structured into	After-school program teachers	10 weeks	Social Cognitive Theory and Self Determin	Intake of whole/minimally processed foods	There was a significant increase in mean frequency of fruit and vegetable intake at post-test compared with pre-test (t = 3.359, p < .01)—an effect size that is	No

		foods, operationalized as fruit and vegetables, and decrease intake of highly processed foods, operationalized as sugar-sweetened beverages, fast foods, and processed-packaged snacks	three units, consisting of three lessons each, followed by a final celebration lesson. Key aspects of lessons included: food rules, film clips, food preparation/tasting, goal setting. (Detailed curriculum components within the paper) Number of participants = 32			ation Theory	(questionnaire) Intake of highly processed foods (questionnaire) Psychosocial mediators of dietary habits (semi-structured interview) Qualitative evaluation (semi-structured interview)	considered to be large (d = 0.59). Small effect sizes (d = 0.34) were seen for mean intakes of highly processed foods but change in score was not statistically significant (p = .06). Statistically significant increases in outcome expectations and self-efficacy for fruit and vegetable intake occurred from pre-test to post-test; all other mediators showed no statistically significant changes. Youth discussed supports for eating fruit and vegetable intake, including social support and modelling, the application of self-regulation skills to increase intake, and their expressed preferences for fruit and vegetable. Youth were also	

								preoccupied with the negative physical outcome expectations of eating highly processed foods, such as developing diabetes.	
	(Brito Beck da Silva et al., 2015)	To promote adequate and healthy eating	Eight meetings lasting 50 minutes each were provided to promote healthy eating and PA. The topics covered were: 1) Healthy eating; 2) PA and sports; 3) Fats, sugars and salt: effects of a poor diet; 4) Nutritional evaluation: the basics; 5) Use of supplements in PA: a critical approach; 6) Food labelling: food and nutritional safety; 7) Role of nutrients in health promotion: functional foods with a focus on fruits, vegetables and legumes; 8) Good food handling practices.	Nutritionists	9 months	None reported	Biochemical profiles (TC, HDLc, TG and LDL) (blood test) Anthropometric data (height and weight) Healthy food consumption (legume and vegetable) (questionnaire)	The intervention group exhibited decreases of 7.64 mg/dL (2.94 mg/dL) in mean TC ($p = 0.009$) and 7.77 mg/dL (2.60 mg/dL) in mean LDLc ($p = 0.003$) and increases of 18% in legume consumption (OR = 1.18; 95% CI 1.03-1.37) and 17% in vegetable consumption (OR = 1.17, 95% CI 1.01-1.35) compared with those who did not undergo intervention at the end of the 9-month follow-up. No differences were noted in the anthropometric parameters studied	No

			A webpage was created in a social network used by the adolescents, in which videos, trivia and general guidelines on healthy eating were posted. For parents and/or guardians, didactic-educational materials were sent through adolescents to encourage them to maintain a healthy lifestyle. Number of participants = 387						
	(Knapp et al., 2019)	To address individual, social, and environmental factors that affect dietary behaviours	Interactive, garden and kitchen-based curriculum classes during school hours as well as afterschool programming for students. Students were involved in growing, harvesting, preparing, and eating food. Programming also extends beyond the classroom to	Program teachers	Not reported	None reported	Student, parent, and teacher perceptions of the intervention Identification of program attributes that	Four primary themes emerged from the focus group data: (1) development of life skills, (2) food and health, (3) family and community, and (4) experiential and participatory learning environment. These core themes and subcategories of the themes were organized into levels of the Socioecological model.	No

			involve families, school staff, and community members in activities and events, such as family food nights, open garden days, and parent cooking classes. Number of participants = 27				are most highly valued Perceived impact of the program on students (focus groups)		
	(Alaimo et al., 2015)	To improve school nutrition practices (including nutrition education) and policies, and to improve student	Schools were asked to convene a Coordinated School Health Team (CSHT) with representatives from various sectors of the school (administration, faculty, food service, health care, and students). Schools were provided with a trained facilitator to meet with their CSHT on one time to complete the healthy School Action Tool (HSAT) healthy	Not reported	2 years	None reported	Adoption of school nutrition practices (including nutrition education) and policies (questionnaire) Student dietary intake	Schools that completed the HSAT prior to but not during the School Nutrition Advances Kids (SNAK) project reported adopting more nutrition policies than schools that never completed the HSAT or a similar program (2.2 vs. 0.4 nutrition policies). Schools that completed the HSAT at any time (prior to but not during the SNAK, during but not prior to, and both prior and during the SNAK project) reported	No

		dietary intake	eating and nutrition topic area (questions on the following topics: school nutrition policies, school nutrition environment, school health education programs including nutrition education, and school food service programs). At the end of each module, schools were to identify several “bright ideas” they could implement. Schools were asked to prioritize their goals and received $1,000 to implement nutrition education or nutrition marketing activities in their action plans. Number of students unknown (40 schools)				(questionnaire)	adopting significantly more nutrition practices than schools that never completed the HSAT or a similar program (6.8, 5.8, 7.0, vs. 1.6 nutrition practices, respectively). Schools that completed a similar assessment or grant program before or after the SNAK project also reported adopting significantly more nutrition practices than schools that never completed the HSAT (4.3 vs. 1.6 nutrition practices). Students in schools that were randomized to complete the HSAT reported consuming significantly more fruit (17.5%) and fibre (4.9%) and less cholesterol (4.2%) than students in the control schools.	

								Students in schools that completed the HSAT during the intervention reported consuming significantly more fruit (20.1%) and fibre (5.1%) and less cholesterol (8.4%) than students in schools that had never completed the HSAT.	
Substance Abuse (n=2)									
	(Vicary et al., 2004)	To reduce the risk for initiation of substance abuse or reduce increased use in high-risk females.	The Life Skills Training (LST) condition, which is usually taught by a limited number of teachers in a series of classes dedicated to substance abuse prevention. The Infused (I)-LST condition integrates life skills training and alcohol, tobacco or other drugs (ATOD) information into a variety of the existing grade level subject curricula	Teachers	2 years	None reported	Students' self-report of: Cigarette use Smokeless tobacco use Alcohol consumption Attitude toward ATOD	The LST low-risk females reported a significantly lower frequency of alcohol use, less binge-drinking, and less marijuana use, while the I-LST low-risk females reported significantly less cigarette smoking. However, the only significant substance use effect that remained for the low-risk females by the end of 8th grade	No

			by the teachers for these subject areas. The goal of such an approach is to make prevention an integral part of the total curriculum. I-LST teachers were trained by university/project staff. Number of participants (LST) = 234 Number of participants (I-LST) = 297				Normative beliefs of peer substance use Knowledge about ATOD Change in program-targeted skills: Decision making skills Communication skills Refusal skills Media awareness Resistance skills Assertiveness Coping with	was [less] cigarette smoking for I-LST. Both LST and I-LST positively affected knowledge of alcohol, tobacco, and other drugs. The I-LST program demonstrated a desirable effect on the normative beliefs of the low-risk females at the end of year two. Among skill variables, treatment effects were found for LST low-risk females for decision making, communication, and coping skills at the end of year one, although, at the end of year two, these effects had disappeared. LST females demonstrated significantly worse media resistance skills at the end of year two. Two skill treatment effects existed for the low-risk I-LST	

							anxiety (questionnaires)	females. At the end of year one, I-LST positively affected decision making skill; however, this effect was reduced to a non-significant level by the end of year two. The I-LST program resulted in greater coping skills by the end of year two for the low- risk females. More positive results were observed, however, for the females at higher risk, with significant treatment effects found in a number of substance use categories. After the first year of programming, high-risk females in the LST program were less likely to use alcohol (both for any drinking and for binge drinking), marijuana, and inhalants	

								A significant treatment effect was also shown among high-risk females in the I-LST program for drinking, binge drinking, and marijuana use at the end of the first year. The LST program significantly affected pro drug attitudes, normative beliefs, and knowledge of ATOD myths and realities although the effects did not remain at a significant level by the end of year two The LST program resulted in two treatment effects for the high-risk females, assertiveness and refusal skills. A significant treatment effect was observed for the high-risk females in the I-LST for normative beliefs by the end of year one, although	

								the effect did not remain through year two. A significant I-LST treatment effect was observed for attitudes toward ATOD and refusal skills at year two among the high-risk females.	
	(Robinson et al., 2003)	To reduce substance use within a sample of low-income, inner-city African American adolescents	School-based health centre (SBHC) social workers and health educators conduct schoolwide prevention/education groups during regular scheduled classes, as well as schoolwide special assemblies and health fairs. The SBHCs operate similarly to a typical physician's office. A student's initial visit to the SBHC includes a comprehensive physical and	A physician specializing in adolescent medicine, a nurse practitioner, a social worker,	6 months for 7th graders and 2 years and 6 months for 9th graders	None reported	Substance use prevalence: cigarettes, alcohol, and marijuana (questionnaire)	For the analysis of cigarette smoking, a significant grade 3 SBHC interaction effect was found, F(1, 585) 5 3.83, p 5 .05. The SBHC students smoked slightly less than non-SBHC students in the 9th grade; but, by 11th grade, SBHC students were smoking significantly less than non-SBHC students. The SBHC 3 grade interaction effect for alcohol use was nonsignificant, F(1, 586) 5 .39, p ..50, although students from	No

			mental health assessment. Alcohol and drug prevention and rehabilitation services are provided in the form of classroom-based preventative health education and individual counselling. Number of participants = 598	a medical assistant , and a health educator				SBHC schools (M 5 1.32, SD 5 3.24) reported drinking slightly less frequently than students from non-SBHC schools (M 5 1.60, SD 5 3.75), this difference was not significant, F(1,586) 5 2.45, p 5 .12 For marijuana, a significant grade 3 SBHC interaction effect was found, F(1, 587) 5 12.72, p , .001. By 11th grade marijuana use had significantly decreased among SBHC students while marijuana use among non-SBHC students dramatically increased.	
PA, Diet, Substance Abuse and Mental Health Interventions									
	(Fardy et al., 1996)	To promote health knowledge and	20–25-minute circuit training classes followed by 5 minute of health behaviours lecture/discussion (topics	PE teacher and assisted	11 weeks	None reported	Health knowledge (questionnair e)	Cardiovascular health knowledge scores significancy increased in the intervention group whereas	No

		behaviour, coronary risk factors, and cardiovascular (CV) fitness	included: exercise, nutrition, smoking cessation, stress management, heart disease, cancer, and motivation). Student workbook from Stanford Adolescent Heart Health Program and the PA and Teenage Health pilot study. Number of participants = 181	by undergraduate and graduate PE majors			Health Behaviour (questionnaire) Coronary risk factors (questionnaire) CV fitness (Vo2max)	they decreased in the control group. Significant changes in self-reported dietary behaviour were observed in female subjects Significant changes in risk factors were restricted to lowered total cholesterol in girls. Mean cholesterol values in female subjects decreased from 165 to 149 mg/dl in the treatment group, whereas female controls decreased from 154 to 150 mg/dl. There were no significant differences in blood pressure, obesity, and self-reported PA. Estimated mean CV improved in females from 33 to 38 ml/kg per min ($P < .0001$), at heart rates of 176 and 152, respectively, whereas control subjects increased	

								only from 33 to 34 ml/kg per min at heart rates of 178 and 172, respectively. In male subjects, treatment and control groups improved from 43 to 52 ml/kg per min and 41 to 49 ml/kg per min, respectively, although the differences between groups were not significant.	
Mental Health and Sleep Interventions									
	(Sibinga et al., 2013)	To improve mental health and reduce stress	Mindfulness-based stress reduction (MBSR) programs consist of three components: didactic material related to mindfulness, meditation, yoga, and the mind–body connection; experiential practice of various mindfulness meditations, mindful yoga, and the "body	A mindfulness instructor	12 weeks	None reported	Psychological functioning (questionnaire) Sleep (sleep diaries and actiwatch) Stress (salivary cortisol)	MBSR participants had less anxiety and a reduction in negative coping approaches (p = 0.06) MBSR participants showed an increase in self-reported anger (p =0.06). Otherwise, there were no significant differences between groups. Among all participants, there was	No

			scan" during group meetings and encouragement of home practice; group discussion focused on the application of mindfulness to everyday situations and problem solving related to barriers to effective practice. Number of participants = 22					an association between the mindfulness subscale "act with awareness" and lower anxiety ($p<0.01$). Among MBSR participants, mindfulness subscales were associated with less self-reported angry temperament (pb0.02) and less anger reactivity ($p = 0.05$). Total cortisol output was not statistically significantly different between groups at baseline or follow-up. Overall, cortisol output was higher post-program ($p = 0.05$). There was a trend towards increasing cortisol over time among 'healthy-topic' participants (113.6 to 167.5, $p = 0.07$); but not among MBSR participants (128.3 to 138.5, $p = 0.33$)	

								Regression analyses of actigraphy data showed no differences between groups in sleep latency (p = 0.29), WASO (p = 0.42), or sleep efficiency (p = 0.97); also, sleep diaries showed no differences in sleep quality (0.67).	
PA, Diet and Substance Abuse									
	(Kerr et al., 2013)	To improve dietary behaviours, PA, and substance use knowledge and behaviours	Promoting Health Among Teens (PHAT) is a culturally tailored intervention for African American adolescents, focusing on 3 dimensions of health behaviour (diet, PA and substance abuse) for premature cancer and cardiovascular disease prevention. The intervention interactive learning activities to increase	Trained interventionists	2 weeks	Social Cognitive Theory	General health knowledge Dietary habits PA levels Substance use behaviours (questionnaires)	PHAT participants had significantly higher knowledge scores than FOY (control) participants ($p \leq 0.0001$), and the rate of increase of condition was significantly higher among PHAT participants than FOY participants ($p \leq 0.0001$). Participants with greater general health knowledge for the centred health knowledge variable had significantly higher intercepts for past week fruit consumption	Yes

			health knowledge, develop health behaviour skills, change attitudes, increase self-efficacy, and explore beliefs regarding personal health behaviours. PHAT utilized cultural pride, goal setting, and instruction in dietary behaviours, PA, nutrition cognition. PHAT was conducted using group facilitation, role-playing, games, and classroom multimedia messages (specific strategies detailed in the paper) Number of participants = 834					($p \leq 0.01$), past week vegetable consumption ($p \leq 0.0001$), past month vegetable consumption ($p \leq 0.0001$) past week moderate PA ($p \leq 0.0001$), past week PA to strengthen or tone muscles ($p \leq 0.01$) lifetime alcohol use ($p \leq 0.01$), and lifetime marijuana use ($p \leq 0.05$). Participants with lower general health knowledge had higher intercepts for past month alcohol use ($p \leq 0.01$) and past month marijuana use ($p \leq 0.0001$). Participants with lower general health knowledge scores had significantly greater slopes for lifetime alcohol use ($p \leq 0.01$). The growth curves for moderate PA and PA to strengthen and tone muscles were not significantly	

								different between PHAT and FOY participants. The level of engagement of vigorous PA was not significantly different between experimental conditions; however, the rates of increase for participants in PHAT were higher than those in FOY. There were no significant differences in growth curve results between experimental conditions for all past month substance abuse behaviour variables, lifetime alcohol use, and lifetime tobacco use. There were significantly higher rates of increase for PHAT participants in lifetime marijuana use ($p<0.0001$). Growth curve modelling indicated that participants in PHAT had	

								significantly more gains in health knowledge than participants in FOY, however the effects on behaviour were modest.	
Sleep Interventions									
	(Quante et al., 2019)	To assess the acceptability of sleep apps	Sleep app use to monitor sleep hygiene. Participants could choose between two commercially available sleep apps: 'SleepBot'© and 'SleepTime'©. Number of participants = 12	App-based	2 weeks	None reported	Use of the app Effects of app on sleep behaviour and quality Challenges with app Desirable components of the app (interview)	There were several barriers identified in relation to the adoption of sleep hygiene interventions, namely reluctance to follow scheduled sleep routines on weekends and concern about "parting" with electronics at bedtime. Participants were intrigued by the idea of adopting an app-based sleep intervention but were skeptical that they could successfully adopt sleep hygiene practices and were more interested in making changes on school days than on weekends.	No

								The overall feedback on two commercial sleep apps was positive, with a good adherence and engagement rate, and perceived health benefits.	
Mental Health and PA									
	(Beaulac et al., 2011)	To promote psychological, social, and physical well-being	The intervention was developed from a thorough literature review, consultation with youth and parents, and ongoing dialogue with community partners. Emphasis was placed on improving dance skills and on fostering positive relationships with peers and adult role model. Number of participants = 67	Dance instructors (Culture Shock Canada)	13 weeks	Socio-Ecological Model	The perceived impact of the intervention, in terms of psychological, social, and physical well-being (focus group, interview & questionnaire)	The findings suggested that the community-based intervention was a promising program for the promotion of youth psychological, social, and physical well-being. The adolescents, parents, and/or personnel described benefits across seven main areas, including dancing and related skills, behaviours (e.g., reduced television viewing), physical well-being, psychological well-being, relationships, respect for others and for diversity, and school performance.	Yes

PA, Diet and Mental Health									
	(Berria et al., 2018)	To improve components of fitness and body image	MVPA, strength and flexibility exercises were increased in PE classes Students were encouraged to use recess time actively with the availability of balls and ropes. Educational sessions were provided on PA, health, nutrition and body image Educational resources used included movie, lectures, confection of posters and music, and cooking workshops Parents were invited to a night-time healthy eating meeting. Number of participants = 328	PE teachers and a nutritionist	13 weeks	None reported	Predictors of dropout: gender, age, SES, PA, screen time, dietary habits, health perception, attitudes and self-efficacy toward PA, perception of the school environment, body image and self-esteem (questionnaire)	In the crude analysis for the entire sample and among students with adequate BMI at baseline, there was a greater probability of dropping out with increasing age and BMI. Students classified as overweight were more likely to drop out with increasing age. In the adjusted analysis, the association with age remained for the entire sample, including students with adequate BMI and with overweight. In addition, for the overweight students, participation in the intervention during the afternoon period and the higher socioeconomic status were associated with dropping out of the intervention.	No

Discussion

The objective of this study was to review the evidence for school-based interventions aimed at HL-related areas in socioeconomically disadvantaged adolescents and to identify effective intervention strategies for this population. To the best of our knowledge, this is the first study to review this topic which is not restricted to a specific region of the world. The evidence collected gives insight into the interventions carried out, and in particular, the success of various strategies implemented with this population, which can be used to guide future intervention development.

Forty-one intervention studies were identified, with the majority carried out in the US. The review aimed to identify studies targeting five health domains (PA, diet, mental health, substance abuse and sleep). The majority of interventions targeted PA, diet and mental health, while very few focused on substance abuse and even less on sleep. This is despite the well-known harmful impacts of substance abuse and poor sleeping habits on adolescents' health and wellbeing (Das et al., 2016; Sussman et al., 2008; Urrila et al., 2017), and the evidence supporting the benefits of behavioural interventions in improving sleeping habits (Griggs et al., 2020) and substance abuse (Das et al., 2016) in youth. Thus, future studies are needed to assess whether interventions targeting sleep and substance abuse are effective in socioeconomically disadvantaged adolescents.

The identified interventions varied greatly in research designs, aims, components, outcome measures and effects, increasing the difficulty to compare and analyse effectiveness per health domain, or across health domains. In addition, although highly recommended (Durlak & DuPre, 2008), only seventeen of the included interventions measured fidelity. This adds to the difficulty of comparing the quality or effectiveness of an intervention, as implementation fidelity of certain intervention strategies within and between studies may have varied greatly. Future studies should include fidelity or process evaluation evidence to allow for a better understanding of the implementation process and to determine whether disappointing results may have been related to poor program delivery (Schaap et al., 2018). Furthermore, there was a high variance in the risk of bias scores obtained, with numerous interventions scoring as ‘high risk’ or ‘unclear’ on multiple aspects of their study designs, adding to the difficulty of interpreting intervention outcomes. Nevertheless, numerous successful intervention strategies were identified. These include ‘hands-on’ or practical learning; peer support; and adopting a holistic intervention approach.

Effective Intervention Strategies

The successful implementation of ‘hands-on’ or practical learning intervention strategies in the studies identified within this review (Luesse et al., 2019; Mendelson et al., 2015; Sibinga et al., 2013) aligns with previous research that states educational activities which are carried out through interactive tasks and are focused on context specific learning, may improve health-related decision making and motivate adolescents to improve behaviour (Bennett et al., 2007; Woods-Townsend et al., 2018). An example of this is ‘LifeLab’ in Southampton; an innovative ‘hands-on’ science-based approach targeting adolescents’ HL through scientific knowledge and lifestyle behaviours (Grace et al., 2012). Interventions identified in this review have demonstrated the effectiveness of peer support in adolescent health interventions (Frenn, Malin, & Bansal, 2003; Frenn, Malin, Bansal, et al., 2003; Sibinga et al., 2013). During adolescence, peer relationships begin to develop, and these relationships are reported to have positive or negative influences on health (Jaccard et al., 2005). Connections with supportive and prosocial peers can lead to healthier behaviours and reduced likelihood of risky behaviours (Viner et al., 2012). In addition, peer modelling and awareness of peer norms can be protective against behaviours such as sexual risk (Vesely et al., 2004) and substance abuse (Donovan, 2004). The findings from this review have further underlined the benefits of peer support by using adolescent peers to design and deliver intervention components (Frenn, Malin, & Bansal, 2003; Frenn, Malin, Bansal, et al., 2003; Sibinga et al., 2013).

This review has provided further evidence for the benefits of adopting a holistic approach to school-based health interventions, rather than just targeting the curriculum element. The WHO HPS framework suggests that school-based interventions should adopt an eco-holistic approach by targeting three key areas; the formal health curriculum, the school environment, and engagement with families or communities (or both) (Langford et al., 2014). While most of the interventions within this review targeted the formal school curriculum dimension of the framework, less were concerned with targeting all three critical elements. The benefit of adopting an intervention framework which targets all three areas is demonstrated by Hollis et al., (2016). Although only one intervention was successful in incorporating all components of the HPS framework (Langford et al., 2014), others which have targeted critical elements, such as parent or community engagement or the school environment (Alaimo et al., 2015; Casey et al., 2014; Frazier et al., 2015; Jackson et al., 2010), appear to foster positive improvements in the health and wellbeing of low socioeconomic adolescents.

Implications of the Identified Interventions Strategies for Socioeconomically Disadvantaged Adolescents

As previously mentioned, socioeconomically disadvantaged populations tend to benefit less from health interventions than those from more affluent backgrounds, often resulting in greater health disparities (Hiscock et al., 2011). Yet, to date there has been limited evidence to inform the design of health interventions for this population (Michie et al., 2009). This review, therefore, has attempted to add to the evidence base by identifying effective and attractive intervention strategies which have been shown to work specifically in this socioeconomically disadvantaged adolescent cohort.

Intervention strategies that involve students carrying out practical activities appear to be more effective than those involving didactic learning. This has been reported elsewhere in lifestyle behavioural interventions targeting adolescents from socioeconomically disadvantaged populations, where students have reported enjoying 'getting away' rather than learning from the classroom (Resnicow et al., 2000). In addition, providing such 'hands-on' activities which are financially inexpensive is crucial when designing intervention strategies for this population, as cost has been reported as being a considerable barrier for participation (Dewar et al., 2013). The strategies implemented in successful interventions included in this review, such as mindfulness activities (Mendelson et al., 2015), yoga (Sethi et al., 2013) and performing "healthy" skits (Mendelson et al., 2015), are very cost-effective and are therefore suitable options.

Peer-learning, in which peers design or deliver (or both) the intervention, appears to be an effective strategy in this cohort. This approach is said to give the students a sense of leadership and empower them to change their lifestyle (Lubans et al., 2011). Furthermore, including the adolescents in the design and implementation of the intervention is crucial, particularly in socioeconomically disadvantaged populations, as it ensures the voice of the student is central to the design, which in turn maximises the potential for the intervention to meet the preferences and needs of the population (Kornet-van der Aa et al., 2017). The WHO strongly advocates the inclusion of peers in the design and implementation of health interventions in socioeconomically disadvantaged populations, as they are trusted by the participants, it leads to greater acceptability and it provides the adolescents with a sense of ownership (Health Organization & Office for Europe, 2013b).

Adopting interventions that consist of more than just a school-based educational element appears to be effective in socioeconomically disadvantaged populations. In particular, involving parents in the intervention as a strategy is important, as parents play a vital role in the lifestyle behaviours of their children (Ventura & Birch, 2008; Frazier et al., 2015; Jackson et al., 2010). In addition, reaching a range of settings in which youth spend most of their time increases the likelihood of long-term intervention effects (Kamath et al., 2008 Frazier et al., 2015; Jackson et al., 2011; Hollis et al., 2016). In a review study, the importance of engaging the parents of socioeconomically disadvantaged adolescents in lifestyle behavior interventions has been highlighted (Golley et al., 2011; Frazier et al., 2015; Jackson et al., 2011), with another study, which failed to change dietary behaviours, stating that the adolescents felt that this was due to a lack of support from their parents (Resnicow et al., 2000). Furthermore, adolescents who perceive their parents to be leading a healthy lifestyle are more likely to also partake in healthy behaviours (Zarychta et al., 2016). Fostering this sort of modelling and parental support through engaging parents in school-based health interventions appears to be a viable solution to improve the impact of interventions in this population.

The Intervention Strategies and Health Literacy

If HL is understood as an observable set of skills, intervention efforts should focus on improving an individuals' skills and capacities (Nutbeam & Lloyd, 2021). Despite this, previous reviews have indicated that existing HL research has been driven by health concerns, which potentially underplays the development of educational outcomes, such as critical thinking, the development of capabilities and motivation for behaviour change (Langford et al., 2014; Peralta & Rowling, 2018). Nevertheless, the current review identifies a number of intervention strategies potentially useful for influencing HL. The classifications of HL provided by Nutbeam (2000) may be a useful way to interpret the strategies identified in the current review (Nutbeam, 2000). Considering interactive HL, the ability to extract health information, apply new information in changing circumstances and engage with others to make decisions, strategies that include practical learning activities and interaction with peers may be of particular use. Many studies included providing the opportunity for shared decision making as part of the intervention (Fröberg et al., 2018; Holmberg et al., 2018; Shinde et al., 2018). Knapp et al., (2019) held interactive classes outside of the classroom (in the kitchen and garden). Vicary et al., (2004) used a life skills training programme to improve the adolescent's confidence and capabilities, specifically targeting decision making skills, refusal skills, media awareness and resistance skills in relation to substance abuse. Including the social support network in an intervention may also be of benefit to increase motivation to change behaviour (Alaimo et al., 2015; Casey et al., 2014; Frazier et al., 2015). Strategies relating to critical HL, the ability to critically analyse information from a wide range of sources, were less prevalent. Only one study (Brito Beck da Silva et al., 2015) attempted to target critical HL by incorporating discussions around a critical approach to the use of supplements in PA, however, many studies used pedagogical techniques and educational resources that could be structured around developing critical HL. For example, discussions (Fardy et al., 1996; Frazier et al., 2015), problem solving (Shinde et al., 2018), role play (Frazier et al., 2015; Kerr et al., 2013), provision of resources (Bandeira et al., 2020; Brito Beck da Silva et al., 2015; Fröberg et al., 2018), and the development of resilience (Dray et al., 2017) were all used when targeting health behaviour change. Such components could be easily delivered through practical activities or involve peer interaction to enhance learning. The use of smaller sessions, with groups of similar individuals, to target consciousness raising and self-re-evaluation, with regular feedback could be offered to improve basic functional

HL behaviours, which enables individuals to function effectively in everyday situations, as this can improve the motivation and maintenance of behaviour change (Frenn, Malin, & Bansal, 2003). Other strategies to consider to improve HL in school aged children may be teacher training (Bandeira et al., 2020; Hollis et al., 2016), as existing HL research has suggested pedagogical guidance will be needed to deliver HL informed curricula (Bröder et al., 2018; Elmer et al., 2020; McCuaig et al., 2012; Paakkari et al., 2019; Peralta & Rowling, 2018), and the holistic approach (previously outlined in the review), which may be a way to incorporate HL as part of the wider HPS framework (Alaimo et al., 2015; Bröder et al., 2018; Casey et al., 2014; Frazier et al., 2015; Hollis et al., 2016; Jackson et al., 2010; Langford et al., 2014),

It should also be acknowledged that strategies that lead to health behaviour change may or may not lead to improvements in HL and vice versa. One such example of this may be that even in a person considered to have a high level of observable HL skills, they may experience real challenges in applying those skills in an unfamiliar environment (Nutbeam & Lloyd, 2021). This should be considered when interpreting the findings of the current study, which found that none of the included interventions explicitly targeted HL, nor did any use HL as an outcome measure. Despite this, as indicated earlier, strategies may be useful and transfer across HL, health promotion and health behaviours, and future research exploring the transferability of these skills, and the relationship between these connected fields is warranted. A factor to consider in the dearth of school-based HL interventions aimed at socioeconomically disadvantaged populations may be the lack of an appropriate tool to measure HL in this context, with interventions to date using adult-adapted HL tools which some have argued to be inaccurate (Massey et al., 2012). As a result, it may have been problematic to place HL as a primary outcome of an intervention. Recently, a tool has been developed specifically for use in adolescent populations, but its applicability is yet to be tested (Paakkari et al., 2019). Furthermore, another HL measurement tool is currently in development, which is following a rigorous co-design process with young people to understand the context and needs of adolescents (Spillane et al., 2020). The development of valid and sensitive measurement tools can be utilized to guide intervention designs to target the specific needs of a particular population and allow for the potential effects to be easily and accurately tracked.

Applying Effective Intervention Strategies

As adolescents encounter unique health issues based on their level of puberty, development, social environment and social context (Sawyer et al., 2012b), caution should be exercised when using previous interventions to inform future approaches. ‘Ready-made’ or ‘one size fits all’ health promotion approaches have become increasingly popular (Williams et al., 2011), yet evidence suggests that interventions developed outside of the targeted schools are rarely meaningful or effective (McCuaig et al., 2008). For health interventions, and in particular HL interventions, to ensure that the health needs and priorities are met it is recommended that they should be co-produced with all relevant stakeholders (McCuaig et al., 2012). This approach values the knowledge and input of key personnel to facilitate deeper engagement in intervention content, and to ensure that interventions are contextual, sustainable, and equity-driven; all of which have been demonstrated in previous HL intervention development approaches (Batterham et al., 2014; Beauchamp et al., 2017). Based on this, effective intervention strategies identified within the review can be used to guide the development of future interventions but should always be contextualised and tailored to suit the targeted population.

Strengths and Limitations

To our knowledge, this is the first study to systematically review school-based HL related interventions in socioeconomically disadvantaged adolescents. The study provides evidence on interventions carried out globally and was not aimed at a specific region of the world. It must be noted that due to the contentiousness of defining socioeconomically disadvantaged populations, studies which self-identified as socioeconomically disadvantaged (or the equivalent) were included. It is acknowledged that included studies would have used different methods to define socioeconomically disadvantaged populations, therefore, this may be a limitation when comparing results of studies within this review. The current review used a standardised and well-established appraisal tool for the assessment of study quality to enable comparison between studies. The Cochrane Risk of bias Tool, however, was originally intended to appraise RCTs (Higgins et al., 2011) and many of the studies included in this review scored poorly or did not report information related to certain aspects of study bias. As a result, the variation between study quality indicates that caution should be exercised when interpreting the results of intervention effects. Due to the large volume of peer-reviewed publications identified and screened in this review, and the practicalities of running and managing the review, the authors did not include a grey literature search. It is acknowledged that by excluding non-published articles, there is an increased risk of publication bias and the possibility of missing out on additional information that a grey literature search may have provided. The large volume of papers included also led to great difficulty in analysing the interaction of different factors in the studies, such as duration of the intervention, setting, key features etc. The authors acknowledge the value that this sort of analysis would have added to the paper. This review included interventions reporting on outcome and process evaluation, yet many interventions did not report on the process evaluation or intervention fidelity. Future research should consider comprehensively reporting intervention evaluation to provide a deeper insight into the intervention delivery.

Conclusion

This systematic review provides evidence on the interventions implemented which aimed to improve HL-related areas in adolescents from socioeconomic populations. The review highlights the lack of interventions targeting sleeping habits and substance abuse in this demographic. In addition, no interventions have explicitly aimed to improve HL. Nevertheless, successful intervention strategies were identified that could be used to inform future intervention development. These include the integration of practical-based learning activities; the use of peer educators; and linking the intervention to the parents and local community.

Linking Chapter 4 to Chapter 5

Phase two of the Ophelia process (Beauchamp et al., 2017) recommends conducting a rapid review of literature to provide evidence to support the selected intervention techniques. As such, Ophelia suggests that the intervention design and implementation is informed by the available evidence, as well as the ideas that emerged from the participatory work carried out in phase 1. Chapter 4 went above and beyond the rapid literature review recommended by the Ophelia process (Beauchamp et al., 2017).

Chapter 4 systematically reviewed a comprehensive range of existing literature around school-based HL interventions (n = 41) targeting adolescents (aged 12 - 16) from low socioeconomic populations. In particular, the review was interested in collating the evidence on interventions focusing on five health domains, including: physical activity and sedentary behaviour; mental health and wellbeing; substance misuse; dietary habits; and sleep. These health domains were reviewed as they had been previously identified as important by the students and teachers from the targeted cohort in the foundational research (Goss et al., 2022). Ultimately, the review aimed to identify intervention strategies and techniques that were effective in improving adolescent HL. Of the 8,074 articles initially identified, 41 articles were included in the systematic review, with the majority targeting PA and diet (n = 13), PA (n = 9) or mental health (n = 7). Few interventions focused solely on substance abuse (n = 2) or sleep (n = 1), and none explicitly targeted or assessed HL as an outcome measure.

Due to the wide inclusion criteria, the number of studies included in the review was high (n = 41), and the interventions reviewed varied greatly in terms of research design, aims, components, outcome measures and effects. This led to great difficulty in comparing and analysing the effectiveness of the included interventions and their intervention strategies per health domain, or across health domains. Despite this, the studies included were analysed and documented to the best of the author's ability. This analysis led to the identification of three common intervention strategies that were effective at improve HL-related factors. The effective strategies that emerged from the review were (i) 'hands-on' or practical learning, (ii) the use of peer support and (iii) adopting a holistic health approach, which targets the school environment, the local community and/or the parents. To the best of the author's knowledge, this was the first study to systematically review school-based HL interventions in this population, therefore, adding valuable knowledge to the field.

Although, these findings can be used to help guide and inform future school-based interventions aimed at improving the HL levels of socioeconomically disadvantaged adolescents, caution should be exercised to ensure that 'one-size-fits-all' approaches are not adopted when using previous literature to inform future interventions. Therefore, the effective intervention strategies identified within this study can be used to guide the development of future interventions but should always be contextualised and tailored to suit the targeted population. For health interventions, and in particular HL interventions, to ensure that the health needs are met it is recommended that they should be co-designed with relevant stakeholders (McCuaig et al., 2012).

Thus far, and in line with the Ophelia framework, the wider project has identified local HL strengths and weaknesses through the development of a series of vignettes (Goss et al., 2021). Next, using co-design workshops with local socioeconomically disadvantaged students and their teachers', five key health domains (food choices, mental health and wellbeing, physical activity and sedentary behaviour, sleep habits, social and environmental factors, and substance misuse) and potential capacity building actions that could be implemented were identified (Goss et al., 2022). These capacity building actions included interactive, applied, and relevant activities; fun and engaging off-site delivery;

and education around the short- and long-term impact of health behaviours. Using all of this information, as well as the data gathered from the systematic review above (Smith et al., 2021), the rough structure of the LifeLab intervention was mapped out. Building on this, the research team drafted ideas for each individual learning activity that would sit within the LifeLab experience. It was essential, however, that that targeted audience were involved in the design of the LifeLab learning activities to increase the likelihood of developing an intervention that was contextually relevant and met the needs of this specific cohort of socioeconomically disadvantaged adolescents.

Chapter 5 of this thesis aims to use the drafted LifeLab learning activities to facilitate co-design workshops with the targeted socioeconomically disadvantaged adolescents to gather their perceptions, feedback, and suggested changes on the individual interactive learning activities. The findings from this study will be used to refine the learning activities for the implementation of the LifeLab intervention and thereby improve its potential efficacy.

Chapter 5: LifeLab: Co-Design of an Interactive Health Literacy Intervention for Socioeconomically Disadvantaged Adolescents

LifeLab: Co-Design of an Interactive Health Literacy Intervention for Socioeconomically Disadvantaged Adolescents

Research Question:

From the perspective of socioeconomically disadvantaged adolescents, what would the core components of a hands-on educational experience aimed at developing the HL of young people be?

Abstract

Low socioeconomic populations, when compared to more affluent groups, are at greater risk of initiating risky behaviours and consequently developing health complications. Health literacy has been identified as a possible means to improve and sustain positive health behaviours, with adolescence being a time point when such behaviours can be embedded. To develop a meaningful health intervention, it has been recommended that relevant stakeholders be included in the design phase. This formative evaluation study was the second phase of co-design of an engaging health literacy intervention 'LifeLab' with, and for, socioeconomically disadvantaged adolescents in Ireland. In Spring 2021, a series of co-design workshops (n = 17) were facilitated with a convenience sample of adolescents from socially disadvantaged areas (n = 22) to gather their perceptions, feedback, and suggested changes on the LifeLab learning activities that had emerged from Phase 1 of the work. The data was analysed using reflexive thematic analysis, resulting in the development of three themes: (i) preferred learning engagement strategies, (ii) practical and logistical considerations and (iii) ideas for LifeLab content. The results highlight the value in adopting a participatory approach, as participants offered an array of suggestions and details to maximise the potential for LifeLab to be

contextually relevant and engaging; suggestions which will directly inform the development and implementation of the intervention.

Keywords: adolescence; health literacy; process evaluation; formative evaluation; health education; co-design; qualitative

Introduction

Despite the clear rationale and justification for school-based HL promotion, the effectiveness of such interventions in improving health behaviours has been equivocal (Khambalia et al., 2012). It has been observed that many studies focus solely on the effectiveness of an intervention, often ignoring the reasons behind why it was successful or not (Olyani et al., 2021; Rowbotham et al., 2019). By including a thorough evaluation of an intervention, such as a formative evaluation, the influences on the effectiveness of the intervention can be assessed (Stetler et al., 2006). Formative evaluation is often deployed during the design phase of a health intervention to optimise the efficacy of the intervention, to assess the strengths and weaknesses, and to ensure that the needs of the targeted population are met. Without formative evaluation, interventions may fail to translate into meaningful health outcomes, with the reasons for that failure remaining unclear, thus providing little guidance for future interventions (Elwy et al., 2020). Adopting a participatory approach allows for research to be carried out 'with' rather than 'on' participants, increasing the likelihood of developing an intervention that is contextually relevant, feasible and sustainable (Slattery et al., 2020). Evidence also suggests that school-based interventions should use integrative and comprehensive approaches to health promotion that target the participants' behaviours, attitudes, and community (Langford et al., 2014). Yet, many interventions fail to involve the relevant participants in the intervention design, which can result in a lack of alignment with the core principles or health issues of the target population (Waters et al., 2011). Ensuring interventions are tailored to the needs of the targeted individuals is particularly important when it comes to low socioeconomic populations, as health interventions targeting, but not specifically designed for, these cohorts often have poor uptake and make little impact, which can lead to a widening of health inequalities (Coupe et al., 2018). This has resulted in a recent push towards including relevant, non-academic partners in the co-design of interventions, partners who have typically been excluded from this phase but can significantly contribute to, and benefit from, health-related research, and in turn reduce research wastage, increase overall impact and address inequities (Brett et al., 2014; Coupe et al., 2018; Minogue et al., 2018).

This project followed the Ophelia framework (Batterham et al., 2014), which aims to involve a range of local stakeholders in developing HL interventions that are based on the diverse HL strengths and weaknesses of the community/cohort in question. The Ophelia process includes three phases (identifying local strengths, needs and issues; co-design of interventions; implementation, evaluation and ongoing improvement) and is underpinned by eight key principles, including being equity driven, outcomes focused, and adopting a co-design approach (Batterham et al., 2014). Using the information gathered thus far from the aforementioned previous research on the project (Goss et al., 2021, 2022); knowledge and guidance from LifeLab Southampton (including the provision of example educational material and practical input); and data from the literature (Smith et al., 2021), the structure of the LifeLab intervention, along with draft ideas for the learning activities in LifeLab, were preliminarily designed by the project team (to allow for further input from young people); which provided the starting point for the current phase of research.

Building on this previous work, this study aimed to investigate adolescents' perceptions of the specific LifeLab learning activities which emerged from Phase 1 (Goss et al., 2022) in order to guide refinements and inform the LifeLab intervention structure prior to a pilot trial, and thereby improve the potential efficacy of this intervention.

Materials and Methods

It is of note that this formative evaluation study was carried in the midst of the COVID-19 pandemic, a time when HL was perhaps more important than ever (Sentell et al., 2020). HL capacities allow individuals to be well-informed about public health recommendations in relation to COVID-19, and to act in ways to best reduce the associated risks of contraction and transmission of the virus (Paakkari & Okan, 2020). Critically, there is a major concern for health equity, with the greatest effects of the pandemic likely to fall on disadvantaged populations (Sentell et al., 2020). The COVID-19 pandemic resulted in closures of schools for large periods of time in Ireland, requiring much of this study to be carried out using methods that complied with government, university and school guidelines and regulations. This research was conducted at a time when Ireland was in a strict lockdown (January–May 2021). These restrictions included the closure of non-essential retail, restaurants/dining, travel restrictions and prohibition of social gathering outside of an individual's "social bubble". Schools had pivoted to online teaching and only reopened for in-person lessons from March 2021 onwards.

Participants and Recruitment

Ethical approval for this study was granted by the institutional research ethics committee [DCUREC/2020/048]. Schools, which had been previously involved in the project were asked if they would like to participate in this phase (Phase 2) of the project. There were no strict inclusion or exclusion criteria, but all schools were part of the Irish Department of Education's 'Delivering Equality of Opportunities in Schools' (DEIS) action plan (Weir et al., 2018). One mixed-gender school ('School A' from here on), who previously participated in Phase 1 of the research (Goss et al., 2022), continued their involvement in Phase 2 of the project. While three other Phase 1 DEIS schools were also invited to participate, they declined due to time and teacher availability; directly citing issues related to the COVID-19 pandemic. To ensure a breadth of involvement in the co-design process, three additional mixed DEIS schools were recruited. School contacts were asked to identify students with a range of diverse backgrounds and interests, across the three years of Junior Cycle education (1st to 3rd year; age 12–16 years), who would be willing to join the workshops. Nine participants from one 1st year class in School A (age 12–13, who had not previously been involved in Phase 1) agreed to take part, and a convenience sample of participants (n = 13) aged 12–15 from the three additional mixed-gender DEIS schools were recruited to form a *Youth Health Forum* (YHF). This brought the total number of adolescent participants involved to 22. The project was explained to all students by the school project contact, and they (and their parents/guardians) were given a plain-language statement and consent/assent forms to complete.

Draft LifeLab Activities

Using data gathered from previous co-design workshops with this cohort (Goss et al., 2021; 2022) and discussions with experts in the field, the LifeLab experience and learning activities were roughly planned and mapped out by the project team, according to the Ophelia Framework (Batterham et al., 2014). This lengthy and sequential process is detailed below:

Initially, the local HL strengths and weaknesses were identified through the development of a series of vignettes (Goss et al., 2021). These vignettes represented typical male and female subgroups across the schools, providing an authentic and tangible description of the health issues and HL profiles of adolescents in this context. Application of these vignettes in workshops involving students and teachers enables active, relevant and meaningful discussions, particularly with young people, as they allow participants to differentiate from themselves, discuss their opinions, and identify in a non-threatening manner. Next, the purposely developed vignettes were explored in a series of eight workshops that were conducted separately with staff and students across four low socioeconomic schools, which resulted in the identification of five key health domains that the participants felt were influential and important to this context (Goss et al., 2022). These health domains included food choices, mental health and wellbeing, physical activity and sedentary behaviour, sleep habits, social and environmental factors, and substance misuse. In addition, the participants identified potential capacity building actions that could be implemented (Goss et al., 2022). These capacity building actions included interactive, applied, and relevant activities; fun and engaging off-site delivery; and education around the short- and long-term impact of health behaviours. Using all of this contextual information, as well as the data gathered from the systematic review (Smith et al., 2021), the rough structure of the LifeLab intervention was mapped out. The LifeLab intervention aimed to include two separate visits for school class groups to the physical 'LifeLab' onsite at Dublin City University (DCU, 'LifeLab 1' and 'LifeLab 2'), in conjunction with school-based learning activities to be implemented by teachers under the 'Wellbeing' curriculum, before, in-between and after each visit. LifeLab 1 and 2 had the goal of developing HL through a hands-on interactive experience, where post-primary students from participating schools would visit the DCU LifeLab to explore and learn about common health issues and health topics previously identified by adolescents and school staff (Goss et al., 2021; 2022). Specifically, LifeLab proposed to provide a carousel of hands-on learning activities that the participants could explore, with each activity focused on a specific health topic (food choices, mental health and wellbeing, physical activity and sedentary behaviour, sleep habits, social and environmental factors, and substance misuse).

Each individual learning activity was designed through extensive co-design work and brainstorming with the research team and experts in the field (e.g., staff from LifeLab Southampton). The focus of this work was to co-design activities that aligned with, and built on, the previous findings of Goss et al., (2021; 2022) and Smith et al., (2021). As such, the individual LifeLab learning activities were drafted one at a time by the research team (led by the lead author) by the identifying the key health issue; identifying HL-related competencies to help tackle the specific health issue; identifying the specific aims and learning intentions for the activity; and then designing an interactive learning experience that aimed to educate the young people on the contextual health issues and the necessary skills to navigate such health issues in their everyday life. Throughout this sequential process, the lead author presented the ideas for each individual learning activity to the LifeLab research team in DCU, and then to experts in the field, to allow for constant feedback, input, and iterative refinement.

Although the overall structure of the intervention, and draft ideas for the learning activities had been preliminarily designed based using the process detailed above, a formative evaluation of the learning activities was required, along with a further co-design opportunity with the key adolescent stakeholders, to finalise the design and implementation of the LifeLab intervention for a pilot trial.

Procedures

A total of 17 co-design workshops (nine with the YHF and eight with School A) were conducted separately between January–May 2021, to discuss the LifeLab activities individually. As a result of the COVID-19 pandemic and the consequential closures of schools in Ireland, most (13 workshops) of the workshops were held over Zoom or Microsoft Teams (depending on the school's preference), with latter workshops being held in a classroom in the school when COVID-19 restrictions were eased (four workshops). Online focus groups have become popular in recent times, with many stating that the quality and quantity of data obtained is comparable to data captured in face-to-face focus groups (Tates et al., 2009). To ensure that the online focus group dynamic was as similar as possible to that of traditional-style focus groups, extra emphasis was placed on establishing a creative, synergistic and non-inhibiting environment by encouraging group discussions and regularly asking additional questions to clarify participants' views (Tates et al., 2009).

The facilitators (CS and HG), who were experienced in HL and health education in post-primary students, followed a structured protocol. The co-design workshops lasted roughly 40–60 min, where one activity was displayed on a PowerPoint presentation (this was the case in the online and in person workshops). The facilitators described the idea for the learning activity to the participants, and in most cases (where possible), the participants completed an adapted online version of the activity to get a sense of how it would work. Upon completion of this and after confirming that everyone understood the activity fully, the participants described and evaluated the station idea using an anonymous polling platform (Vevox, 2021 Auga Technologies Ltd., Godalming, UK). Firstly, participants were asked to use their own words to describe the idea for the activity, with their suggestions displayed as a word cloud only after everyone had contributed as many/few words as desired. This was followed by questions using a 5-point Likert scale to evaluate how interesting, fun, engaging and exciting the participants found the idea for the activity. The primary purpose of this initial element of the workshop was to get the participants thinking about the activity and their perceptions, before delving into a deeper analytical discussion. This process followed the method discussed by. Morrison-Beedy et al., (2001), which suggests introducing the level of questioning gradually to develop rapport within the group and to allow for deeper discussions around a given topic. Building on the participants' responses, the activity was then discussed in more detail using a semi-structured question guide. As well as expanding on the responses from the polling platform (e.g., Why did you find the activity so interesting/fun/engaging/exciting?), the question guide aimed to ensure that the practicalities, acceptability, and equity of each activity idea was thoroughly discussed. The final, and perhaps most critical, element of the workshops involved inviting participants to share and discuss their ideas on how the station could be refined, improved, or enhanced, or to offer completely new ideas for learning activities, if they had any. All co-design workshops were audio-recorded using a digital dictaphone, and reflective diaries were used to record insights and ideas by the two facilitators and a critical observer, which were discussed immediately after the workshop.

Analysis

Reflexive thematic analysis (RTA) (Braun & Clarke, 2021) was conducted to analyse the data gathered. RTA is about the researchers' reflective and thoughtful engagement with their data and their reflective and thoughtful engagement with the analytic process (Braun & Clarke, 2019). The findings, therefore, primarily reflect the first author's (CS) analysis of the data. Aligning with the principles of RTA, the co-design workshops were conducted with flexibility and fluidity to reflect a real-life conversation, providing the researcher with the freedom to be responsive to the participants' feedback and input. This approach aimed to create a relaxed environment and allowed for an in-depth analysis of the participants' perceptions of the LifeLab learning activities and intervention more generally. An inductive coding approach was adopted, focusing on deriving semantic and latent codes and generating themes linked to the data acquired. An experiential orientation to data interpretation was adopted to explore the participants' contextually situated experiences and perspectives on the intervention and was underpinned by a constructionist epistemology. As such, the interpretation of meaningfulness was highly influential in developing codes and themes (Braun & Clarke, 2021).

The data was analysed using Braun & Clarke's (2019, 2021) six-phase approach to RTA. First, the data was manually transcribed verbatim to Microsoft Word. Each transcript was then read multiple times to ensure familiarity and understanding of the data before systematic coding began. After the full dataset was coded using a qualitative analysis software (QRS NVIVO-12), the initial themes were generated from the codes. The initial themes were then reviewed, developed and structured. Throughout this process, the themes were refined, defined and named. The reporting phase was completed after the codes and themes developed.

Throughout the data collection and analysis, a reflexive journal to record key information, interpretations and insights that were constantly reflected on during the analytical process. This allowed for the author to engage with the data, deepening reflexivity (Braun & Clarke, 2021). Due to the reflexive and interpretive nature of RTA, the first author predominantly analysed the data. As a method of further validating the analysis conducted, Dr. Hannah Goss audited the reflexive analytical process by sense-checking analysis and exploring alternative interpretations of the data (e.g., suggestions made by students regarding important health topics). This method of sense-checking and the "critical friend" approach to analysis encouraged a deepened reflexivity by offering alternative interpretations of the data in a manner that was collaborative and flexible, ultimately leading to richer interpretations of meaning, rather than aiming to achieve a general consensus (Braun & Clarke, 2021).

Following the guidance of Smith and McGannon (2018), throughout the data collection the first author utilised member reflections to enhance depth and robustness of findings. The aim of these reflections was not to verify results or find correspondence with the truth, but to generate further insight and data (Smith and McGannon, 2018). No participants felt that their thoughts or ideas were misinterpreted. This reflective piece did, however, facilitate further discussions on key points (e.g., discussions around key engagement strategies and additional solutions to existing problems).

Results

Using the polling platform, the most common words used by the participants to describe the LifeLab activities included: exciting, interesting, fun, cool, innovative, and different (see appendix C for example word cloud). The quantitative scores from the Likert scale evaluation were not formally analysed. Responses to the Likert scale evaluation questions, however, were used to facilitate detailed discussions around the LifeLab activities, specifically the factors that they most and least enjoyed.

Following the RTA of the data gathered, three themes, with subsequent sub-themes, were generated: (i) preferred learning engagement strategies, (ii) practical and logistical considerations and (iii) ideas for LifeLab content. Table 5.1 presents all themes and sub-themes with exemplar quotes.

Table 5.1 Themes and Subthemes

Theme	Sub-Theme	Example Quote
Preferred Learning Engagement Strategies	Healthy competition	*I think if you even like put the groups against each other… it would make it like a bit competitive and then everyone would want to do it, as most people are competitive (YHF participant)*
	Interactive tasks	*Yeah, it was good; it was fun as well to be interactive and you weren't waiting around for long (YHF participant)*

	Problem solving	*Will there be like obstacles on it? Is it going to be almost like a maze? (School A participant)*
	Providing variety and choice	*I liked how there was like different sections that you could choose (YHF participant)*
Practical & Logistical Considerations	Amount of time per learning activity	*It would probably be best to make it around 10 min, even longer maybe (School A participant)*
	Number of students per activity	*I don't know, it depends on how big the group is. 10 people is gonna be kinda hard to get everyone (involved), but if it's 5/6 it's easy to get a smaller group to work together on one thing. If it's bigger, people are being left out (YHF participant)*
	Creating the appropriate physical space	*I thought the colours and the objects in the room were really important (YHF participant)*
Ideas for LifeLab Content	Relating the content and learnings to real life	*I think seeing the effect of a lack of sleep on the vignettes because even though they're fictional, it's probably not too far off from some people in the class. So that would maybe, like, make them [think]… oh, maybe I shouldn't be doing that (YHF participant)*

	The influence of social media on young people	*He (the vignette) is believing stuff on Instagram that could be fake (School A participant)*
	Lifestyle behaviours and their impact on health	*I think it's important to show, like, how your choices now, even though they might be small, and they might not seem significant, how they can, like, build up in your body (School A participant)*

Theme: Preferred Learning Engagement Strategies

During the co-design workshops, the participants highlighted specific strategies that they felt would enhance the engagement of young people with the LifeLab activities. These strategies were recommended as methods that could be adopted to create appealing, exciting and enjoyable health-related learning activities. The suggestions included incorporating healthy competition; interactive tasks; problem solving to various stations; and ensuring that there was variety and choice across and within learning activities.

Healthy Competition

The participants identified healthy competition as a key strategy to engage and interest young people in learning about health. This was discussed across various activities with one YHF participant suggesting that "everyone would want to take part more if there was, like, competition involved" and that it would make it "more fun for everyone". Despite advocating for an element of competition in the learning activities, participants were also wary of its potential pitfalls, stating: "It could be fun. But at the same time, I wouldn't want [to be] the people that don't win. Like, I wouldn't want them to kind of disengage from that" (YHF participant).

This highlighted the participants' awareness of ensuring that the element of competition was fair and that it didn't result in some individuals being excluded from the activity and learning. This was emphasised by one participant who stated that "it's important that if we were gonna do some competition that it's still fun and relaxing and enjoyable", and that the form of competition is crucial to consider:

"I think it might be better to have a point system so that if you don't get an answer, you don't just stand, like, on the side-lines or in like a corner waiting for everyone else to be finished. And like, if the point system was fair, it would be more fun because then you wouldn't have to be worried about, like, getting knocked out" (YHF participant).

Interactive Tasks

The participants identified interactive tasks as an engaging (and informative) strategy in LifeLab, particularly when they were fast paced. This was clearly articulated when the YHF participants commented the following after completing an idea for an activity: "it was fast and interactive, you didn't have time to get bored" and "I liked how they were short and sweet, but they still have a little bit of information, so you learn something from it". Furthermore, bringing the learning to life through use of a familiar or established game was well received by the participants, with one participant stating that they enjoyed the idea of creating "a game that everyone knows into something that, like, links in with health and wellbeing" (YHF participant). This was particularly the case when the participants could physically complete a task during the game:

"I think for the puzzle part, as long as it's not like on paper and it's interactive or you can physically do it together… It will be more memorable and more interesting and get people more involved" (YHF participant).

These insights suggest that the participants wanted to avoid being stationary during the learning (as may be typical in a school classroom), and that to elicit a "positive reaction" from young people, learning activities which incorporate an element of physical activity or movement would be more effective in maintaining engagement: "If it was just like sitting down, like, on iPads and just playing Kahoot, I think they'll be boring" (YHF participant).

Problem Solving

Incorporating an element of problem solving into the learning activities was a popular idea among the participants. Although problem solving was not directly defined by the young people, the desire for an element of problem solving was typified by the following quote by a YHF participant when discussing an idea for the LifeLab learning activity: "I feel like if there's almost like a complicated puzzle, like where a group of people would be able to figure it out. That's what makes it really fun, I guess".

Students also expressed their interest in including an element of problem solving by asking for such activities within the learning activities: "Will there be like obstacles on it? Is it going to be almost like a maze?". These types of activities appeared to excite and interest the students. Finally, another student highlighted how incorporating "time management (discussed earlier) at the same time as problem solving" would be "really fun".

This was also evident during a discussion on developing a learning activity to explore food choices, when a School A participant suggested making the activity into a game that would involve participants "trying to work it out".

In the workshops, the participants discussed how they would like to work in "teams" to complete problem solving activities, rather than "having the spotlight on one person".

Another reason for the participants preferring to work as a group was that they could seek out help from peers: “If one person was confused…they could all kind of help each other out”, which would make the activities “more fun” and “less stressful” (YHF participants). In addition, the participants from School A felt the level of difficulty was an important factor to consider. When discussing ideas for an activity on sleeping habits, the participants mentioned that the questions originally designed for the activity were “very easy” and they asked for “harder questions” to avoid the answers being “a little bit predictable”, causing the activity to go by “faster because it is very easy”. In contrast, participants were keen to avoid the activities being “too difficult to think about” as a result of asking too many questions on a given topic and they acknowledged it would be “difficult to kind of hit the balance” when it came to creating educational content for the activities.

A common observation from the participants, across multiple learning activities, was the importance of including an element of “time pressure” to the problem solving to maintain engagement, with some claiming that the “time crunch kind of makes it” and that: “If the timer wasn’t there, I think everyone else would kind of be bored of waiting for them to answer” (School A).

Participants even suggested using the time pressure to create competition between participants: “It’d be like really interesting to see who got the fastest time and who got the slowest time” (YHF participant).

Providing Variety and Choice

The workshop participants emphasised the importance of providing variety to engage young people, with multiple participants commenting on how they enjoyed the fact that all activities were different:

“It stands out, but in a good way because you kind of need variety… if you have too many similar games, people might get bored of them after a while… so I think it’s really good” (YHF participant).

Furthermore, offering choice to participants was deemed crucial as “it is important to have something to engage all types of people”. This was particularly evident during an activity focused on highlighting the importance of sleep hygiene, which involved some students listening to meditative audio while sitting in a ‘relaxation zone’. One student commented on this idea by saying:

“A lot of people do meditation because it helps them, but they do it by choice. Meanwhile, if someone just turns on a video and says sit still now and listen and do this. Like, for some people doing nothing is just really hard and it makes them more stressed then relaxed, so it has the opposite effect” (YHF participant).

This feedback emphasised participants’ recognition that not all health-promoting techniques are effective for everyone, along with the importance of providing a suite of options for participants to choose from when demonstrating, and educating on, healthy techniques: “You’d probably have to ask someone…who is in the station (learning activity) which one would they prefer” (School A participant).

Theme: Practical and Logistical Considerations

In order to ensure that the LifeLab intervention was as enjoyable as possible, numerous practical and logistical considerations were highlighted by the participants during the co-design workshops. These included considering the amount of time spent on each activity; the number of students completing each activity at a given time; and creating an appropriate physical space for the participants. These considerations are strongly linked with, and are indeed complementary to, the learning engagement strategies detailed above.

The Amount of Time per Learning Activity

During the co-design workshops, participants discussed the amount of time that they would ideally spend on each activity. In conjunction with this, the students highlighted their desire for fast-paced activities; they also emphasised the importance of keeping the activities short enough to maintain engagement and interest:

"I don't want to have to play it until I get bored. I think it would be good to cut it off at an exciting point so that we look back on it happy rather than like 'oh it went on and on'" (YHF participant).

When asked specifically about the amount of time they would want to spend on each activity, the responses varied greatly between participants, and also depended on the activity in question being discussed. One student suggested completing an activity for "two hours" while another suggested "six minutes". On average however, participants recommended staying on one learning activity for roughly 10–30 min before moving to another, with key feedback highlighting the importance of not "staying on one thing for too long" and keeping the activities short enough to avoid disengagement or boredom.

The Number of Students Completing a Learning Activity at One Time

During a discussion around the number of students that would ideally complete a single learning activity at one time, the participants were keen to ensure that the group size was not too large: "I feel like if it is too big some people might not get the experience of it. I'm thinking like definitely less than ten [people]" (YHF participant). In order to guarantee that everyone has the chance to benefit from the activity, others suggested the number per group should be even less: “I think up to five people is good because it gives everyone a chance to speak if they want to” (YHF participant).

Adding to the concern for LifeLab attendees feeling excluding or “left out” of the learning, the participants who recommended working in teams during activities strongly suggested that such teams comprise of “pairs” or “two to three people”, as “it’s easy to get a smaller group to work together on one thing” and would still allow for participants to “ask their friends for help”, if needed.

Creating an Appropriate Physical Space

The importance of the physical space in LifeLab was highlighted during the co-design workshops. This was particularly evident when it came to activities where the participants had the opportunity to practise mindfulness or relaxation techniques. For such activities, participants wanted to ensure that the physical space created the appropriate environment to engage in the intended activity: “So for example, the meditation one, like little lava lamps, or you know them lights that make them colours, stuff like that would be really cool” (YHF participant). Another participant suggested including “bean bags and blankets” for the LifeLab attendees to create a “relaxing type of place”. They even commented on the impact of the colour schemes adopted, stating that in order for LifeLab to create an “aesthetic” and “visual” appeal, the activities and LifeLab space should include “warm tones or even bright colours… like green… to make it like refreshing or calming” (YHF participant).

Theme: Ideas for LifeLab Content

Throughout the discussions on the specific LifeLab learning activities, the participants provided feedback on not only the methods to engage young people in health-related activities, but also on the content itself. The feedback highlighted the importance of including learnings that were meaningful and helpful to young people in their context.

Relating the Content and Learnings to Real Life

Participants were keen to have content and learnings in LifeLab that they felt were relatable and could be applied to their own lives. As part of many of the LifeLab activities discussed in the co-design workshops, contextually relevant vignettes (developed in Phase 1, (Goss et al., 2021)) were employed to allow participants to freely discuss health topics and behaviours, explore their own health concerns, and develop solutions to real-life health challenges. The participants engaged with the characters very well and provided positive feedback on their use:

"I liked the long one—what was it called?—where you read a little bit [about the vignette] and then you have to give them advice. I like that one because it's something that you can almost make up on the spot, but it just makes you think a little bit more" (School A participant).

When asked about how we could improve specific activities, the participants replied with "add more scenarios [vignettes]" and add "different people [vignettes]". The purpose of the vignettes, which was to engage the young people and allow them to relate the learnings back to their own life in a non-judgmental manner, appeared to be effective. This was demonstrated when one participant described how the process of discussing and analysing the vignette's poor sleeping habits, might cause a young person to re-evaluate their own sleeping habits: "So that would maybe, like, make them be like, you know, oh, maybe I shouldn't be doing that" (School A participant).

The participants also suggested directly analysing their own health through LifeLab activities. One activity discussed in the co-design workshops, which was aimed at developing HL around sleeping habits, observed how different behaviours prior to sleep impacted brain and heart-rate activity, and subsequently affected one's ability to obtain an adequate night's sleep. Rather than just visualising the impact of these behaviours on a computer screen, and possibly only seeing a peers' physiological response, one member of the co-design workshops suggested:

"I would probably enjoy it if you could like print out like what information you got from like the brain scan and the heart-rate monitor, I feel like that would be really interesting… so you can see how your brain reacts to what you were doing and how your heart-rate reacts" (YHF participant).

Participants wanted to "learn things" from LifeLab that they could "put into their daily lives". This was evident when discussing an activity aimed at food choices, where they stated: "I feel like it's also a good idea because then people could think about what food they should and shouldn't consume, and like what they can do to change their diet and like how they can fix it".

The Influence of Social Media on Young People

Social media and its daily influence on young people came up in conversation across many of the workshops. The participants mentioned how many of the interactions between peers in school are based on current trends on "TikTok and Instagram":

"Ninety-five percent of the jokes that me and my friends make, and people at school that I hear, are from TikTok. It has such a vast spreading, like if a TikTok goes well, everybody knows about it and everybody gets the joke… so, I feel like that influences people so much nowadays" (YHF participant).

The participants went on to describe how it is not just entertainment content that young people are engaging with on social media, often they use these platforms for health-related information:

“Like some doctors and nurses are on TikTok and they’re trying to inform people of, like, some health conditions or like even what to do if you’re feeling kind of sick or something” (YHF participant).

According to the participants, the health information shown on these outlets is mostly focused on eating habits and exercise, where influencers post “workouts” and “what to eat in a day” videos. The participants acknowledged that often these influencers are attempting to “make themselves look perfect” and that the way they look and behave is often not “normal”, yet they still recognised that their content can often be detrimental to young people’s health:

“Social medias, and like basically photoshopped images of the perfect body, can affect a lot of people’s mental health” (School A).

Lifestyle Behaviours and Their Impact on Health

The co-design workshops highlighted the need and desire for education around lifestyle behaviours and the potential impacts that they can have on the body and health more generally. The participants articulated this by asking for more content on “the consequences” of lifestyle choices. In particular, they were interested in learning about “what they’re doing right and what they’re doing wrong” and how these behaviours can alter quality of life:

“It was really exciting getting to see like how your decisions would, I know you haven’t seen it yet, but how your decisions would affect something that you can’t see on the outside…But like they have an influence on your life” (YHF participant).

Participants also identified the body as something that they would like to learn more about, specifically how the body changes as a result of lifestyle choices, or how we can "ruin the body". This was mentioned after trialing an activity aimed at highlighting the impact of substance misuse, where the students had to match up a body part with the appropriate behaviour (e.g., unhealthy lungs, with cigarette smoking):

"I wouldn't really know how the body looks overall healthy and how it looks like not healthy, so it's going to be very interesting to see what I would think is, like, a healthy looking body and what I wouldn't think…and I would learn about what the body should look like and what the body shouldn't look like, you know, so it's very educational at the same time" (School A participant).

Furthermore, not only did the young people want to know how the appearance of the body might alter as a result of lifestyle choices, but they also wanted education around changes to the how the body functions as a result of specific behaviours:

"You could kind of go and show some information about, like, your lungs and like, I don't know, I guess how they work more efficiently maybe…you know the people who smoke, their lungs wouldn't be very healthy…and then people who exercise, they would have a better lung capacity" (School A).

Discussion

The research aim of this study was to formatively evaluate, and co-design future content, of 'LifeLab'; an out-of-school HL engaging learning experience for socioeconomically disadvantaged adolescents. To achieve this aim, co-design workshops were carried out with a diverse group of adolescents from DEIS schools, which were focused on obtaining feedback from the young people on the LifeLab learning activities and suggested refinements in order to ensure maximal acceptability and efficacy of the intervention going forward. The findings offer a valuable insight into young people's perceptions of HL education, specifically methods which may be used to engage young people, practical considerations for implementing an HL intervention, and the health-related content that young people in this context feel is meaningful and important to learn about.

Regarding the engagement strategies, the participants' feedback highlighted the appetite for an intervention which is hands-on and interactive. This aligns with literature suggesting that interactive learning outside of the school classroom provides memorable experiences that can track into adulthood and have lasting impacts on health behaviours (Bay et al., 2017; Bennett et al., 2006; Grace et al., 2012; O'Donnell et al., 2006; Smith et al., 2021). Moreover, interactive learning activities that incorporate context-specific learning have been shown to improve adolescents' HL and potentially health behaviours (Bay et al., 2017; Bennett et al., 2006). This has been already modelled by LifeLab in Southampton; an innovative, hands-on, science-based approach targeting adolescents' HL through scientific knowledge targeting human biology, lifestyle behaviours and critical thinking (Woods-Townsend et al., 2018). Findings from LifeLab Southampton's pilot studies have demonstrated that such an intervention can have a positive impact on adolescents' health-related attitudes and knowledge (Woods-Townsend et al., 2018). Adopting similar pedagogical approaches in the current context will provide evidence on whether similar findings are generalisable to socioeconomically disadvantaged adolescents in Ireland.

The use of competition in education is a contentious topic, with some stating that by adding a competitive element the focus shifts away from the learning process and onto the competitive goal (Lam et al., 2004). Others, however, are strong supporters of its use. For example, Lawrence (Lawrence, 2004) believes competition encourages active learning and increases motivation, while Fasli and Michalakopoulos (2005) state that it acts as an incentive for students to put in more effort and can allow for academically weaker students to engage in an activity. 'Healthy competition' has been defined as a short activity where the focus is on the learning process rather than the results, and the outcomes are trivial (Shindler, 2009), with team-based competition posing less risk for the task to become solely goal focused in young people (Shields & Funk, 2011). Furthermore, it has been recommended that in order to facilitate healthy competition in education, it must be conducted over a short period of time, provide a range of topics and tasks, allow everyone the opportunity to succeed, allocate a clear value to the learning process and quality, and aim for enjoyment (Shields & Funk, 2011). In line with the above, suggestions from the participants in this study support that including short bouts of healthy competition within learning activities may provide a viable method to capture young people's attention to maximise engagement and facilitate their learning of HL-related content.

Problem-Based Learning (PBL) is a method of learning that often involves students working collaboratively to define and solve a problem while developing communication and critical-thinking skills (Hung, 2011; Shields & Funk, 2011). Though the term 'PBL' was not used by participants, PBL strategies were often central to suggestions made by participants for enhancing student engagement with the LifeLab learning stations. Savery

(2006) defines it as a learner-centered approach that empowers individuals to interrogate an issue and apply knowledge and skills to develop a viable solution. This method allows participants to acquire knowledge through peer-learning rather than depending on the teachers to disseminate information. Instead, teachers can act as facilitators of learning who can scaffold participants with effective questioning and guidance (Ertmer & Simons, 2006). To allow for productive and constructive peer-learning, the participants requested that the groups (teams) were small enough to allow for all participants to have an opportunity to maintain their desired involvement in the task, a suggestion echoed in the literature (Dolmans et al., 2015; Haidet et al., 2012). The aims of PBL overlap with goals of HL development, where the enhancement of higher-order skills, such as comprehending, reasoning, critical thinking and application, are critical (Nutbeam, 2000). Moreover, given the self-directed style of PBL, whereby students use reflexive thinking and have the opportunity to develop the communication, team-work and interpersonal skills required for everyday life, it appears to be a fitting method to educate on real-world health-related situations.

In order to maintain engagement in the LifeLab activities, the level of difficulty needs to be considered, according to the co-design workshop participants. Shields and Funk (Shields & Funk, 2011) stress the importance of finding the balance in tasks, in that they need to be both challenging and achievable. They explain that when tasks are deemed too easy by young people, it results in boredom and disengagement, but when tasks are too difficult, young people will become frustrated and lose interest. In order for LifeLab activities to maintain participant engagement, the level of difficulty of the content must be appropriate for its intended target audience. Similarly, the amount of time the participants wanted to spend on each activity was a talking point across the workshops. The participants emphasised that they wanted enough time to be able to complete the tasks fully and enjoy the competitive element but mentioned that if the activities were repetitive or took too long, they would lose interest. For most of the participants attending the co-design workshops, this appeared to be anywhere between 10–30 min, but for some it was significantly less. This highlights the need for flexibility in the design of engaging health interventions for young people and the importance of tools or techniques to re-engage those who lose interest (Nett et al., 2010).

Another factor to be considered when designing a health intervention, which was discussed in the workshops, is ensuring that the health-related educational content is tailored to the context and contains learnings that can be applied to the participants' own lives. Many of the LifeLab activities discussed in the co-design workshops utilised contextually relevant vignettes previously developed using data gathered from a similar demographic (Goss et al., 2021). These vignettes are short stories which enable participants to engage in discussions around individuals they would 'recognise' or relate to from their community with varying levels of HL. Vignette methodology is used to explore attitudes, values and perceptions of health issues, and other sensitive or controversial topics (Jackson et al., 2015). They allow the participants to engage in controlled discussion around a relevant and realistic character, whereby individuals can differentiate from themselves, discuss their opinions on a given topic and identify in a non-threatening manner. The use of vignettes in the workshops was very effective, with participants actively engaging in the content and even requesting that more vignettes be utilised in future LifeLab activities. Although the vignettes employed were validated with this population previously (Goss et al., 2021), written vignettes may still act as a barrier for engagement, given the low literacy levels of the targeted adolescents (Weir et al., 2018). It is, therefore, important to consider the methods used to present the vignettes in order to improve accessibility. Viable methods to remove this barrier, which have been demonstrated in previous research, may be the use of audio-visual (Eifler, 2007) or digital (McInroy & Beer, 2022) versions of the peer vignettes. The discussions around the vignette's lifestyles and health behaviours provided rich insights into the challenges that adolescents from this cohort face and allowed the participants to identify areas of learning that not only interested them, but that they felt would help tackle the HL-related challenges that they and their peers encounter in their everyday lives. Some of the suggestions made by participants for future learning in LifeLab included educational content around the impact of lifestyle behaviours on the body's appearance and its ability to function; 'good v bad' lifestyle behaviours; and the influence of social media on young people. Although 'less is better' is often suggested in relation to screentime (Sanders et al., 2019), today's young people are digital natives, battling with the overabundance of (valid and invalid) information and material available at their fingertips (Okan et al., 2020) and navigating new health risk behaviours (Purba et al., 2021) associated with screens. Yet alongside this, technology could be a way to facilitate the preferred learning engagement strategies and overcome some of the practical and logistical considerations cited by participants in this study. There is, therefore, a need to balance these considerations to develop functional, interactive and critical health literacy for participants within LifeLab.

This study highlights the process of a co-designing and formatively evaluating complex health interventions, whereby the young people targeted have the opportunity to create something that is meaningful to their context, is equity driven, and is sustainable. It is recognised that too often interventions are based solely on academic theory and lack the contextual understanding required (Moore & Evans, 2017). This has led to a surge in interventions utilising a participatory approach in recent years. The value in such an approach is highlighted throughout the findings of this study, where participants provided invaluable feedback on the learning activities and overall intervention. Moreover, it has been stated that involving socioeconomically disadvantaged adolescents in the design of a health intervention not only increases the likelihood of producing an efficacious intervention that meets the needs of the targeted population (Kornet-van der Aa et al., 2017), but also provides designers with a sense of ownership which can empower them to improve their lifestyle (Lubans et al., 2011). The WHO are strong advocates for involving peers in the design of health intervention, particularly in ‘hard to reach’ populations, as they believe it contributes to greater acceptability and provides a sense of leadership (World Health Organization, 2017).

Limitations

Findings of the study aside, it is not without limitations. The COVID-19 pandemic caused major disruptions to the project. First, this study was intended to be carried out in person, rather than remotely, allowing participants to physically trial the learning activities before engaging in co-design workshops. Due to local government restrictions, this was not possible and therefore required us to pivot to remote methods, such as Zoom and Microsoft Teams. This led to challenges in describing the ideas for the learning activities as well as the concept of LifeLab, possibly resulting in some confusion from participants. In order to clarify our intentions, the facilitators of the workshops used clear and concise PowerPoint presentations to describe the learning activity; designed online versions of the practical activities for the participants to engage with; and constantly checked for understanding to ensure that the participants grasped the station/activity content. Despite these efforts, it is very difficult to replicate an in-person experience online. In addition, this was the research teams' first-time gathering data using this online methodology, so, as to be expected, it was not without hiccups. Furthermore, COVID-19 impacted the recruitment of participants. As a result of the subsequent pressures on schools, three of the four previously recruited schools opted out of this phase of the study. Although the YHF were consequently recruited, the total sample was still relatively small. Finally, limited participant demographic information was gathered and reported in this study. This was due to the online nature of much of the work, with the ethics committee within the university limiting the gathering of personal data of minors where online work was taking place. The research team acknowledge the value in adding this level of information, particularly when dealing with socioeconomically disadvantaged populations.

Conclusion

This study details the co-design of an engaging HL intervention targeting socioeconomically disadvantaged adolescents. The findings highlight key strategies for engaging young people in HL learning, practical and logistical considerations when implementing an engaging HL intervention, and content that adolescents from this population feel is meaningful and valuable to learn about. The methodology undertaken provides key stakeholders with the opportunity to develop a contextually tailored intervention that has the potential to tackle health inequalities in this population. Participants co-designed multiple interactive learning activities which are aimed at improving HL across various health domains. While the findings are most directly relevant to the LifeLab intervention itself and will directly inform its content and structure, there are learnings from this study which can be applied by teachers and researchers alike in developing educational content. In addition, findings support the importance of the methodological approach taken, an approach which can be replicated across other demographics in order to refine elements over time and also to co-design and formatively evaluate future interventions.

Linking Chapter 5 to Chapter 6

As per phase two of the Ophelia Framework (Batterham et al., 2014), chapter 5 co-designed and formatively evaluated the LifeLab learning activities with adolescents from socioeconomically disadvantaged populations. Specifically, a series of co-design workshops (n = 17) were facilitated with a convenience sample of adolescents from socially disadvantaged areas (n = 22) to gather their perceptions, feedback, and suggested changes on the LifeLab learning activities. These learning activities were previously developed by the research team using information gathered from the previous co-design work with the targeted cohort (Goss et al., 2021; 2022), the available and relevant literature (Smith et al., 2021) and discussions with experts in the field (e.g., LifeLab Southampton). The qualitative data gathered from the co-design workshops was analysed using RTA, resulting in the development of three themes: (i) preferred learning engagement strategies, (ii) practical and logistical considerations and (iii) ideas for LifeLab content. Examples of the preferred learning engagement strategies included incorporating healthy competition; interactive tasks; problem solving; and ensuring that there was variety and choice across and within learning activities. Regarding the practical and logistical considerations, the students discussed and provided recommendations on the amount of time to spend on each activity; the number of students that would complete an activity at a given time; and creating an appropriate physical space for the participants. The participants also suggested that the educational content within the LifeLab experience must be applicable to their own life. Moreover, they advised including education around the influence of social media on young people and how lifestyle behaviours impact on an individual's health and wellbeing.

Not only did the study provide valuable information on potential methods to engage young people in health education; the content that young people from this context feel is meaningful and important to learn about; and practical and logistical considerations for implementing an engaging HL intervention, but it also provided evidence base for an effective methodology to carry out participatory research, particularly when it is difficult to implement in-person methods. Although this stage of the research project took place during the COVID-19 pandemic, it was essential that the students provided feedback and guidance on the learning activities to ensure the acceptability and feasibility of the LifeLab experience. The authors acknowledge that carrying out the co-design workshops face-to-face in an environment free of COVID-19 restrictions would have been the optimal method, however the use of interactive online co-design workshops proved very effective in gathering the students' perceptions of the activities. In particular, the use of the interactive PowerPoint presentations to describe the ideas for the learning activities to the participants, and the use of the polling platform (Vevox) to gain an insight into the participants initial impressions of the activities, which ultimately helped to guide the direction of the deeper discussions. These simple, yet effective, techniques contributed heavily to the flow of the workshops, but also to the richness of the data gathered. Although this methodological approach can be replicated across other settings and demographics to increase the potential impact of future interventions, the findings are most relevant to the LifeLab intervention itself and will directly inform its design. The data gathered was used to refine the overall structure of the LifeLab experience (the duration of the learning activities, the physical setting and the breakdown of students per activity); the educational content that sits within the experience (real-life health-related situations, content on the influence of social media and the implications of lifestyle behaviours); and the specific techniques that will be used to interest and engage the students during each learning activity. Thus, the LifeLab experience that was drafted in the earlier phases of the research project was refined and physically prepared using the information from this study in preparation for intervention implementation.

Chapter 6 will build on these developments to process evaluate the nine-week LifeLab intervention, which is focused on improving HL levels of socioeconomically disadvantaged adolescents. The intervention consists of two separate visits for school class groups to the physical LifeLab ('LifeLab 1' and 'LifeLab 2') onsite at Dublin City University (DCU). The two LifeLab experiences were co-designed in the previous study. In conjunction with these two visits, teachers will implement seven school-based lessons as part of the 'Wellbeing' programme before LifeLab 1 (2), in between the two LifeLab visits (3) and after the LifeLab 2 visit (2). This mixed-methods process evaluation will examine the overall intervention (school-based and LifeLab experiences) and is primarily focused on exploring the acceptability of the different elements of the intervention from the students' and teachers' perspectives. The secondary focus is to assess the fidelity, reach, dose delivered and effectiveness of the nine-week intervention. The findings will be used to guide and inform the necessary refinements of the various intervention elements in preparation for future implementation of the LifeLab intervention.

Chapter 6: A process evaluation of LifeLab; an interactive health literacy intervention for socioeconomically disadvantaged adolescents

A process evaluation of LifeLab; an interactive health literacy intervention for socioeconomically disadvantaged adolescents

Research Questions:

1. How do teachers and students engage with the developed intervention components, and how might they be adapted to improve acceptability, implementation, and fidelity?

2. To what extent does the LifeLab intervention impact socioeconomically disadvantaged adolescent's motivation to adopt healthier behaviours?

Abstract

This mixed-methods process evaluation examines the acceptability, fidelity, dose delivered, reach and effectiveness of a nine-week, school-based HL intervention for low socioeconomic adolescents named LifeLab. The intervention, which comprised of two, out-of-school, interactive HL experiences in conjunction with seven school-based lessons, took place over the course of three months and involved a full first year cohort (aged 11 – 13) from one socially disadvantaged school in Dublin, Ireland. Data sources included focus group interviews, enjoyment scales, a questionnaire, fidelity and implementation checklists, attendance records and an adapted version of the Behavioural Regulation in Exercise Questionnaire. Overall, the intervention was perceived positively by the students (n=97) and teachers (n=3), particularly the two interactive out-of-school experiences. The teachers highlighted some issues with the volume and level of difficulty of the school-based content, impacting the number of school-based lessons delivered. The reach and fidelity of the LifeLab visits were high, but the intervention did not result in a statistically significant difference in the adolescents' motivation to adopt healthier behaviours. The

evaluation provided valuable insight into the refinements and modifications required to enhance the efficacy of the LifeLab intervention.

Key words: Health Literacy; Adolescence: Socioeconomically disadvantaged; Schools-based intervention; Process evaluation

Introduction

Often health interventions focus solely on outcome measures, such as the effectiveness, ignoring the reasons behind why an intervention may or may not have produced the desired outcome (Rowbotham et al., 2019). Process evaluations, which have been recognised as an essential part of intervention research, help to understand the relationship between program elements and the programs outcomes (Glasgow & Linnan, 2008). Several reasons can explain low level of intervention's effectiveness such as poor implementation, poor program design or insufficient reach (Moore et al., 2015). Process evaluations observe and assess an intervention in detail to provide information on how to refine or adapt the intervention. It also supports the preparation for an intervention's implementation in real-world settings (Borrelli, 2011).

Process evaluations tend to be guided by multiple frameworks (Borrelli, 2011; Dusenbury et al., 2003; Glasgow et al., 2019; Glasgow & Linnan, 2008; Moore et al., 2015; Proctor et al., 2011; Saunders et al., 2005), with common components such as reach, dose, fidelity, acceptability. For this chapter, and based on the aims of the study, the following process evaluation components have been considered: (i) *acceptability*, the stakeholders' perception of the acceptability and satisfaction of the intervention (Proctor et al., 2011); (ii) *reach*, the proportion of the intended audience that participated in the intervention (Saunders et al., 2005); (iii) *dose delivered*, the number of intended units of the intervention delivered (Saunders et al., 2005); (iv) *fidelity*, the extent to which the intervention was implemented as planned (Saunders et al., 2005); (v) *effectiveness*, the impact of the intervention on important outcomes (Glasgow et al., 2019).

Following on from previous work, where the intervention was co-designed and formatively evaluated by participants from the targeted population (Smith et al., 2022), the LifeLab intervention was implemented. This mixed-method process evaluation primarily aims to report on the acceptability of the LifeLab intervention from the students' and teachers' perspectives. Secondarily, the study aims to report on the reach, dose delivered, fidelity and effectiveness of the intervention. This trial intends to capture information on the implementation of the LifeLab program to inform the planning of a future, larger scale intervention.

Materials and Methods

The LifeLab Intervention

The LifeLab intervention is a nine-week HL intervention targeting adolescents from a socioeconomically disadvantaged school (DEIS school as per Weir et al., 2018), which took place between September 2021 and December 2021. The intervention, which was underpinned by a set of core principles agreed by the project team (Appendix I) and the Self-Determination Theory (Deci & Ryan, 2012), consisted of two separate visits for school class (n = 4) groups to the physical LifeLab ('LifeLab 1' and 'LifeLab 2') onsite at Dublin City University (DCU). The two LifeLab visits were previously co-designed with adolescents from low socioeconomic populations (see study 2). In conjunction with these two visits, teachers implemented seven school-based lessons as part of the 'Wellbeing' programme, before LifeLab 1 (2), in between the two LifeLab visits (3) and after the LifeLab 2 visit (2). These lessons were requested by the teachers, as they felt it was important to supplement the out-of-school experiences with a short school-based curriculum. Unlike the LifeLab visits, it was not possible to co-design the school-based lessons due to the difficulties faced engaging with teachers and students, as well as heightened time pressure on the school community, due to the COVID-19 pandemic. All school-based materials were designed by the research team (led by Dr. Hannah Goss), which included experts in intervention design and health education from Dublin City University, University College Dublin, and health promotion officers from the Irish Heart Foundation. In addition, discussions with, and materials provided by, experts from LifeLab Southampton also assisted in the development of the lesson plans. The lessons aimed to prepare the students for, and build on the learnings of, the LifeLab visits. In addition, the lessons provided an opportunity for the students to showcase their learning from the LifeLab visits, through a mini project-style task. Throughout the course of the intervention, the research team emailed participating teachers who were delivering the material to provide assistance and ensure that there were no difficulties with the lesson content or delivery (no issues were reported during the intervention). Examples of the school-based lessons are detailed in appendix M. The two LifeLab visits were hands-on, interactive experiences where post-primary school adolescents would visit the DCU-based lab for 90 minutes to explore and learn about common health issues. These health issues (food choices, mental health and wellbeing, physical activity and sedentary behaviour, sleep habits, social and environmental factors, and substance misuse) were previously identified by the teachers and students of the target population (Goss et al., 2022). The hands-on LifeLab experiences (LifeLab 1 and LifeLab 2) were broken into five individual learning activities per visit, each lasting roughly 15 minutes, and focused on one of the health issues mentioned above (descriptions of the activities are attached, see Appendix J). The students completed the activities in small groups (4-5 students), which were led by a facilitator (Physical Education or Sports Science and Health undergraduate students from DCU who received training from the research team). Each learning activity was previously discussed by the target audience in co-design workshops, where the adolescents had the opportunity to input and design the activities to ensure that they were contextually relevant and had the potential to tackle health issues in their area (Smith et al., 2022). A table detailing how the learning activities align with the previously co-designed elements is included as appendix K.

Participants and Recruitment

Ethical approval for this study was granted by the research ethics committee in September 2021 [DCUREC/2021/192]. One post-primary DEIS (Weir et al., 2018) school in Dublin, which had been previously involved in the co-design and formative evaluation elements of the project, was asked if their first-year cohort (age 11 – 13) would like to participate in the LifeLab intervention. The project was explained to all students by the school project contact, and they (and their parents) were given a plain language statement and consent/assent forms to complete. Students were only allowed to take part in the study if they had returned the completed forms.

Process Evaluation Framework and Data Collection

This mixed-methods process evaluation used a modified (described in the introduction) framework (Glasgow et al., 2019; Proctor et al., 2011; Saunders et al., 2005), which primarily aimed to explore acceptability, and secondarily aimed to measure reach, dose delivered, fidelity and effectiveness (see table 6.1).

Table 6.1. Process evaluation components, research questions and data sources

Process Evaluation Component	**Research Question**	**Data Source**
Acceptability (primary outcome)	To what extent was the LifeLab intervention appropriate for the participants? (Proctor et al., 2011)	• Student focus groups • Student Enjoyment scales • Teacher focus group • Teacher questionnaire
Dose Delivered	What number of intended units of the intervention were delivered? (Saunders et al., 2005)	• Teacher checklist • Implementation checklist
Delivery Fidelity	Was LifeLab delivered as intended? (Saunders et al., 2005)	• Implementation checklist
Effectiveness	What impact did the intervention have on motivation to change health behaviours? (Glasgow et al., 2019)	• Adapted Behavioural Regulation in Exercise Questionnaire

Reach	What proportion of the intended audience attended LifeLab? (Saunders et al., 2005)	• LifeLab attendance

Data sources

Acceptability

Student Focus Groups

Focus groups were chosen to collect data on the acceptability of the LifeLab experiences from the student's perspective as they would allow for rich, contextual discussions. Semi-structured focus groups took place immediately after each LifeLab visit to obtain the students' feedback and perceptions of their LifeLab experience. The students were divided evenly into two or three groups of six to eight participants, with each group assigned a researcher to facilitate the discussion. The focus groups lasted roughly 15 minutes and followed a simple pre-planned question guide (Appendix F) to understand the elements of the LifeLab experience the students most and least enjoyed, and to identify suggested changes to create a more acceptable LifeLab experience. Focus groups were conducted by CS, SB, HG, SM and were audio recorded using a digital dictaphone.

Enjoyment Scales

To the best of the author's knowledge, there was no fit for purpose psychometrically valid tools available for measuring the enjoyment of this health intervention. Given the nature of the intervention, and the fact that each individual learning activity required evaluation, it was essential for this tool to be administered quickly and with ease, to avoid major disruptions to the flow of the LifeLab experience. Immediately after completing each learning activity during LifeLab 1 and LifeLab 2, the students completed an anonymous enjoyment scale to rate their experience at that specific activity. The students' enjoyment was scored on a five-point Likert Scale, which ranged from "very enjoyable" to "really didn't like it". The students completed this by placing a sticker in the box associated with the appropriate response, which took no more than 60 seconds. The data acquired from this assessment would be used to guide the post-LifeLab focus group (detailed above). For example, if one learning activity scored particularly poorly or particularly well, this was discussed in greater detail in the focus group discussions.

Teacher Focus Group and Questionnaire

At the end of the intervention, the teachers completed a short questionnaire, followed by a focus group, to gather their feedback and opinions on the overall LifeLab intervention. The questionnaire consisted of five-point Likert scale questions. These questions were developed by the research team and were specifically tailored to the intervention, allowing the teachers to rate (i) the various elements of the intervention, (ii) how prepared they felt implementing the intervention, (iii) the resources for the school-based lessons and (iv) the communication from the research team. Immediately after completing the questionnaire, teachers took part in a 40-minute focus group. The aim of the focus group was to build on the questionnaire and explore the teachers' perceptions of the intervention to guide the iterative development of the intervention. Specifically, the intervention's acceptability, feasibility and practicality were discussed to identify barriers and facilitators of implementing the intervention and methods to improve its efficacy (for full question guide, see appendix G). With this in mind, a semi-structured focus-group guide, using questions designed by the research team who had specific expertise in qualitative research design, was developed. The focus groups were facilitated by CS and HG and were audio recorded using a digital dictaphone.

Dose Delivered

Teacher Checklist

As part of the end of intervention questionnaire, the three teachers involved the intervention completed a short checklist to detail the elements of the intervention they did/did not implement (or attend, in the case of the LifeLab visits). The specifics can be seen in table 6.7 below.

Fidelity

LifeLab Experience Fidelity Checklist

During each LifeLab session, a critical observer (a member of the research team) followed a single group of students as they completed their five LifeLab learning activities at each visit (LifeLab 1 and LifeLab 2). The critical observer assessed the delivery and design of the activity by completing a checklist to ensure that each activity aligned with the LifeLab core principles and theoretical constructs (SDT, Deci & Ryan, 2012) (Appendix I). The LifeLab core principles were developed by the research team, underpinned by the Ophelia framework (Batterham et al., 2014), and supported by the literature (Michie et al., 2011). The implementation checklist consisted of four-point Likert scales questions, ranging from 1 (low) to 4 (high). All questions are detailed in table 6.8. A mean of above 2.5 was considered high fidelity. This is a commonly accepted method to evaluate the delivery and fidelity of interventions (Moore et al., 2015), and was deemed feasible to carry out in this setting.

Reach

The students' attendance was measured at each LifeLab visit. The reach was measured by comparing the number of first year students that attended each LifeLab to the total first year student cohort.

Effectiveness

Unfortunately, to the best of the author's knowledge, there were no contextually relevant tools available to measure changes to the HL levels of the adolescent cohort. Instead, to assess the effectiveness of the intervention, a tool was used to measure the adolescent's motivation to adopt healthier behaviours (general health behaviours). To measure the impact of the intervention in terms of the participant's motivation to adopt healthier behaviours, an adapted version of the Behavioural Regulation in Exercise Questionnaire (BREQ, Mullan & Markland, 1997) was utilised pre- and post-intervention (two weeks before the start of the intervention and two weeks after completion). The BREQ-2 is a questionnaire that measures the stages of the self-determination continuum with respect to motivation to exercise with a five-point Likert scale (0=not true for me, 4=very true for me). Rather than focusing solely on exercise, the questionnaire was adapted to capture information on the participants' motivation to change the health behaviours more generally. To adapt the original tool, the format and design of the questionnaire was kept the same, however, the wording was modified as minimally as possible to assess motivation to change health behaviours more generally. For example, one question from the original BREQ states *"I exercise because other people say I should",* whereas the adapted version used in this study reads *"I try to be healthy because other people say I should be healthy"*. This method of adaptation was used in all included questions (for the full list, please see appendix N). Some questions on the original BREQ were not included in the adapted version as the authors did not feel they could not be adapted appropriately, nonetheless, questions targeting all stages of the SDT (intrinsic regulation, identified regulation, introjected regulation and external regulation) were included to ensure that each element of motivation was measured. The assessment was carried out in the school-classroom and was administered by the research team. As with the original BREQ, a brief introduction to the questionnaire was read out to the students to ensure they all understood the process.

Data Analyses

Process evaluation findings are presented using both qualitative and quantitative data sources. The time points of the process evaluation measures are detailed in table 6.2 below.

Table 6.2. Time Points of Process Evaluation Measures

			Process Evaluation Component				
Evaluation Method	**Data Collection Timing**	**Intervention component**	**Acceptability**	**Fidelity**	**Dose Delivered**	**Reach**	**Effectiveness**
Student Focus Group	Immediately after LifeLab 1 and 2	LifeLab experience	✓				
Enjoyment Scales	During LifeLab 1 and 2	LifeLab experience	✓			✓	
Teacher Focus Group	Post intervention	School-based element & LifeLab experience	✓				
Teacher Checklist & Questionnaire	Post intervention	School-based element & LifeLab experience	✓		✓		
Implementation Checklist	During LifeLab 1 and 2	School-based element & LifeLab experience		✓	✓		

Adapted BREQ	Pre & post intervention	School-based element & LifeLab experience		✓

Analysis of Qualitative Data

Reflexive thematic analysis (RTA) (Braun & Clarke, 2021) was conducted to analyse the data gathered. RTA is about the researchers' reflective and thoughtful engagement with their data and their reflective and thoughtful engagement with the analytic process (Braun & Clarke, 2019). The findings, therefore, primarily reflect the first author's (CS) analysis of the data. Aligning with the principles of RTA, the co-design workshops were conducted with flexibility and fluidity to reflect a real-life conversation, providing the researcher with the freedom to be responsive to the participants' feedback and input. This approach aimed to create a relaxed environment and allowed for an in-depth analysis of the participants' perceptions of the LifeLab learning activities and intervention more generally. An inductive coding approach was adopted, focusing on deriving semantic and latent codes and generating themes linked to the data acquired. An experiential orientation to data interpretation was adopted to explore the participants' contextually situated experiences and perspectives on the intervention and was underpinned by a constructionist epistemology. As such, the interpretation of meaningfulness was highly influential in developing codes and themes (Braun & Clarke, 2021).

The data was analysed using Braun & Clarke's (2019, 2021) six-phase approach to RTA. First, the data was manually transcribed verbatim to Microsoft Word. Each transcript was then read multiple times to ensure familiarity and understanding of the data before systematic coding began. After the full dataset was coded using a qualitative analysis software (QRS NVIVO-12), the initial themes were generated from the codes. The initial themes were then reviewed, developed, and structured. Throughout this process, the themes were refined, defined, and named. The reporting phase was completed after the codes and themes developed.

Throughout the data collection and analysis, a reflexive journal to record key information, interpretations and insights that were constantly reflected on during the analytical process. This allowed for the author to engage with the data, as well as a method of deepening reflexivity (Braun & Clarke, 2021). Due to the reflexive and interpretive nature of RTA, the first author predominantly analysed the data. As a method of further validating the analysis conducted, Dr. Hannah Goss audited the reflexive analytical process by sense-checking analysis and exploring alternative interpretations of the data. This method of sense-checking and the “critical friend” approach to analysis encouraged a deepened reflexivity by offering alternative interpretations of the data in a manner that was collaborative and flexible, ultimately leading to richer interpretations of meaning, rather than aiming to achieve a general consensus (Braun & Clarke, 2021).

Following the guidance of Smith and McGannon (2018), throughout, and at the end of, the data collection, the first author utilised member reflections to enhance depth and robustness of findings. The aim of these reflections was not to verify results or find correspondence with the truth, but to generate further insight and data (Smith and McGannon, 2018). No participants felt that their thoughts or ideas were misinterpreted. This reflective piece did, however, facilitate further discussions on key.

Analysis of Quantitative Data

Data on the delivery fidelity, enjoyment scales, teacher questionnaire, teacher checklist and reach data were analysed using descriptive statistics using Microsoft Excel and are presented as the mean, unless otherwise stated. A Wilcoxon Signed Rank Test was conducted to investigate significant differences between groups for the effectiveness measures -pre and -post intervention. Statistical analysis was performed using SPSS for Mac (version 27, SPSS, Chicago, IL, USA), with a *p*-value of 0.05 used to denote statistical significance.

Results

Participant Descriptive analysis

In total, 97 students (51 females, 45 males and 1 non-binary) 1st year students were recruited. The age range of the students was 11 - 13. No ethnicity or socioeconomic status data was obtained from the participants. For CONSORT diagram highlighting the participant flow, see appendix G.

Acceptability

Student Enjoyment Scales

The results from the enjoyment scales for LifeLab 1 and LifeLab 2 can be seen in Table 6.3.

During LifeLab 1, the learning activity that the students appeared to enjoy the most was the social and environmental factors activity, with 64.6% finding it 'very enjoyable' and 25% reporting that it was 'enjoyable'. This was followed closely by the physical activity learning activity, where 59.9% found it 'very enjoyable' and 30% found it 'enjoyable'. Only 25.3% of students found the food choices activity 'very enjoyable' but 41.8% thought that it was 'enjoyable'. In addition, the sleep activity was quite divisive, 8.9% found that they 'really didn't like it', 10.1% said it was 'not enjoyable', however, 41.8% thought it was 'very enjoyable'.

Table 6.3. LifeLab Enjoyment Scales

LifeLab 1 Learning Activity	Very enjoyable % (n)	Enjoyable % (n)	It was okay % (n)	Not enjoyable % (n)	Really didn't like it % (n)	Total number of responses
Physical Activity	58.9% (43)	30.1% (22)	9.6% (7)	0% (0)	1.4% (1)	73
Sleep	40.5% (32)	26.6% (21)	13.9% (11)	10.1% (8)	8.9% (7)	79
Mental Health	35.1% (27)	37.7% (29)	22.1% (17)	2.6% (2)	2.6% (2)	77
Social and Environmental Factors	64.6% (51)	25.3% (20)	7.6% (6)	1.3% (1)	1.3% (1)	79
Food Choices	25.3% (20)	41.8% (33)	22.8% (18)	5.1% (4)	5.1% (4)	79
LifeLab 2 Learning Activity	**Very enjoyable % (n)**	**Enjoyable % (n)**	**It was okay % (n)**	**Not enjoyable % (n)**	**Really didn't like it % (n)**	**Total number of responses**
Physical Activity	64.3% (45)	28.6% (20)	5.7% (4)	0% (0)	1.4% (1)	70
Sleep	48.5% (33)	30.9% (21)	19.1% (13)	1.5% (1)	0% (0)	68
Mental Health	47.3% (35)	32.4% (24)	10.8% (8)	0% (0)	9.5% (7)	74
Substance Misuse	45.1% (32)	32.4% (23)	8.5% (6)	4.2% (3)	9.9% (7)	71
Food Choices	8.2% (6)	41.1% (30)	27.4% (20)	4.1% (3)	19.2% (14)	73

The physical activity learning activity was also popular among the students in LifeLab 2, with 64.3% reporting that it was ‘very enjoyable’ and only 1.4% stating that they ‘really didn’t like it’. This was followed by the sleep activity, with 48.5% and 30.9% finding it ‘very enjoyable’ and ‘enjoyable’ respectively, and only 1.5% found it ‘not enjoyable’ and none of the students reported that they ‘really didn’t like it’. The substance misuse and mental health learning activities were also scored highly, with most of the students finding them either ‘very enjoyable’ or ‘enjoyable’, however, roughly 10% reported that they ‘really didn’t like’ either activity. The food choices activity was the least popular learning activity at LifeLab 2, with only 8.2% of students finding it ‘very enjoyable’. Furthermore, 19.2% reported that they ‘really didn’t like it’.

Student Focus Groups

All students took part in the focus groups. In total, 22 focus group interviews took place after each LifeLab visit. Following the RTA of the gathered data, four themes, with subsequent sub-themes were generated: (i) the impact of the LifeLab intervention, (ii) factors that facilitated an acceptable experience, (iii) factors that inhibited an acceptable experience, and (iv) methods to improve the acceptability of the intervention. Table 6.4 presents all themes and subthemes.

Table 6.4. Themes and Subthemes from Student Focus Groups

Theme	Sub-theme
The impact of the LifeLab intervention	The novelty of the experience
	The educational content
Factors that facilitated an acceptable experience	Game-style learning activities
	Physical activities
	Relaxing element
	The challenging and competitive elements
Factors that inhibited an acceptable experience	Repetitive elements
	Difficult or confusing elements
	Lack of interaction
Suggested changes to improve LifeLab	More time
	The equipment
	The LifeLab space

Theme: The Impact of the LifeLab Intervention

Sub-theme: The Novelty of the Learning Experience

Overall, the students appeared to enjoy their time in LifeLab. This was particularly evident when they highlighted how the novelty of LifeLab contributed to an enjoyable, but also informative experience, with one student describing how LifeLab “was something different” and that it “puts learning into a fun way”. Another student added “you go there and it’s just little games about health”, but that “we take it (the learning) in more because it’s something fun to do and you’ll want to tell your friends ‘Oh, I went to LifeLab today and I did this’”.

The students compared LifeLab to traditional learning by stating “you’re learning, but it’s fun and school is boring” and that “it’s tricking people into thinking it’s fun, but you’re actually learning something”. In addition, the students enjoyed “getting out of school to come down (to LifeLab)” to “have fun”. This highlights the benefits of the interactive and out-of-school experience that LifeLab provides.

Sub-theme: The Educational Content

Not only did the students find LifeLab “cool” and enjoy the style of learning, but they also felt that the educational content covered within the LifeLab experience was valuable. When discussing the benefits of LifeLab for adolescents, the students mentioned how they “liked it because it teaches you not to just trust everything you see on the internet”. Others highlighted the enjoyment in learning about “mental health… like how to keep active and how to keep your mind off bad things” and “about what affects your body”. Although, some had covered some of the content previously, they felt that LifeLab provided clarity around specific topics: “I knew it but it like makes more sense now”. Furthermore, one student stated that LifeLab provided “more information than you get to learn in school”.

Theme: Factors that Facilitated an Acceptable Experience

Sub-theme: The Game-Style Learning Activities

A factor which appeared to contribute to the students’ enjoyment in LifeLab, was the game-style learning incorporated into many of the LifeLab activities. When discussing elements of LifeLab that they particularly enjoyed, the students mentioned how their “favourite part of it (LifeLab) was the games”, and that they enjoyed the experience because “it’s just like loads of different games”. Furthermore, the students seemed to enjoy the wide range of games offered, with some mentioning how they enjoyed “who wants to be a millionaire" as they were able to "buzz the buzzers and answer the questions", and others enjoyed games "where you had to try and find a match", and some liked playing traditional games such as "snakes and ladders" or "the ping pong game". These findings highlight the importance of providing a variety of different style activities in LifeLab.

Sub-theme: Physical Activities

The students stated that they enjoyed being physically active during the LifeLab experience, with learning activities involving physical movement among their favourites. Incorporating physical activities into the learning appeared to work well, with one student saying, "I liked how we actually done physical activity and then answered questions", which was more enjoyable than "just doing questions". Another student discussed how "sitting and learning is boring, (it is) better to be doing something with it", and that including physically activities "instead of just looking at things" enhanced the LifeLab experience. The students cited the "boxing bag", the "reaction wall", the "bike", "dancing" and "golf" as some of their favourite forms of physical activity in LifeLab.

Sub-theme: Relaxing Elements

In contrast, the students mentioned how they enjoyed the relaxing elements of LifeLab. During both the sleep and mental health learning activity, the participants were provided the time and space to carry out relaxation techniques of their choice. In the focus groups, one student expressed his enjoyment of the activity by stating: "the relaxation was actually brilliant". The students picked out specific elements of the relaxation that they enjoyed, with one student saying they "loved the weighted blanket" and how they were able to "put on relaxing music" which helped to "calm down" and "relax my brain". The students highlighted how "you could get comfortable easy" and that "they didn't have to do anything, just sit there". Another commented on how "you had a pillow to lie down, you had a big blanket, and you had a neck pillow”. This demonstrates the importance of including high and low energy activities in LifeLab; providing the students with the chance to practise, and learn about, mental health techniques as part of their LifeLab experience.

Sub-theme: The Challenging and Competitive Elements

The students enjoyed being challenged during their LifeLab experience. This was particularly evident during the game-style activities where an element of competition was incorporated:

“Everyone thought it was easy because they were just playing snakes and ladders, but then when you pop out the questions… we were like ‘oh it’s not that easy’”. The competition was intended to be light-hearted, aimed at increasing engagement. This appeared to be effective, with students mentioning how activities were “just funny and competitive”. Although, this enjoyment was particular evident when the students were successful in the task, with one student saying, “I loved it when I am the winner”. Students, however, did acknowledge the benefits of competition, regardless of the outcome with one participant highlighting the fact that including an element of competition or a challenge “provides motivation” to get involved in the task.

The perceived level of difficulty ranged within and across activities with some students saying, “it’s too easy” and asking for future version to be more difficult: “I would have liked it as it would have put more pressure on you to get them all right”. Others felt “it was hard”, which “got your brain working” and was “fun”. Regardless of the level of difficulty, including a completive game or a challenge in the learning activity was well received by the students.

Theme: Factors that Inhibited an Acceptable Experience

Sub-theme: Repetitive Elements

The students felt some of their experience was repetitive, with one student expressing how one task "just repeated the same thing over and over again". Another student, when discussing a card matching game, said "just in general it didn't feel good, it just felt bland… like you sit there, and you match a card and put something on a wall then repeat it until the end".

The students compared the repetitive activities to other activities, which they felt were more engaging and enjoyable as they included more variety: "The quiz one was good cause they were all different questions, all different changes, and then like the card one or the poster one was just the same thing for the whole class". The students recommended adding "little challenges" or "activities" to "prevent repetitiveness". Others suggested changing the rules of the game to maintain engagement:

"It would be good if like the rules changed or something, for example you have a certain amount of lives or if you hit the barrier you have to like do something".

Sub-theme: Difficult or Confusing Elements

Elements of LifeLab were considered confusing or difficult for some of the participants, which contributed to a less enjoyable experience. The students mentioned that some activities "just didn't make sense" and felt that at times "they didn't really know what you were doing". The students elaborated by pointing out that to reduce confusion, some activities needed to be explained and demonstrated clearly prior to commencing the task:

"In the end I knew how to do it, but it sounded confusing… They didn't do a practice or anything, you just got to action so like you didn't know how do the first round".

Other tasks were considered "too hard" as a result of the content being "too smart". The students asked for the activities to be "less complicated" or to provide tasks which range in difficulty: “like you can have an easy one if you find that one hard and then you can have a medium (difficulty) one”. This would allow students of all academic abilities to engage and enjoy the learning activities.

Sub-theme: Lack of Interaction

Some of the learning activities that were enjoyed the least by the students were the food choices and sleep activities during their first visit to LifeLab. Several of the students found that these activities were “boring” as they just “sat there and answered a few questions”.

These two activities contrasted with the other learning activities, which involved more movement and interaction. During the sleep activity, the students were divided into ‘scientists’ and ‘participants’, where the scientists’ role was to analyse the brain activity of the ‘participants’ while they completed various behaviours. Although, the students who acted as ‘participants’ enjoyed their element of the activity, many students who acted as ‘scientists’ found the learning activity less appealing: “The thing you could improve with the science (sleep) one is that there could be more stuff to do as a scientist because all you were doing was looking at a screen and answering questions”, whereas the participants “could do a bunch of stuff”.

Similarly, the students found that the food choices activity lacked excitement and suggested that it could be improved by including more interactive elements. When asked how this activity could be improved, one student responded by saying “maybe more interactions, because all you were doing was writing down stuff and all the other ones, we were actually like seeing stuff and interacting with stuff. Whereas for that one, we just had a pen, and we were working”. The students also suggested making the activity into a “competitive game” where they were required to “taste real food”.

Theme: Suggested Changes to Improve LifeLab

Sub-theme: More Time

The students felt that some of the learning activities were "a bit short" and wished that they "could have had more time". Some participants wanted more time on the activities as they were having "fun" and wanted to "try out different stuff", whereas others felt they "didn't have enough time to know how to do it (the activity)". When discussing how much more time they would like on the learning activities, most said "at least five more minutes", but others asked for "an extra ten minutes" per activity. The lack of time was emphasised by one student, who, when describing his experience of the social and environmental factors activity, said he felt as though it "just got started and it was over". Furthermore, students wanted their overall experience in LifeLab to be "way longer" and asked for "more time in LifeLab". They felt they would enjoy spending "the whole day in LifeLab" or "two hours and 30 minutes". One student used the idiom "time flies when you are having fun!" to describe their time at LifeLab.

Sub-theme: The Equipment

The students expressed their dissatisfaction towards some of the LifeLab equipment at various learning activities. They felt that certain items were outdated and that others were not fit for purpose. This was evident when the students discussed how the computer game that they used at the sleep learning activity was obsolete, and that "a new PlayStation" and "a newer version of FIFA" were needed. Another student stated that "the dance mat wasn't picking up my moves correctly, and it just made out that I was bad". The students also highlighted how the "tents needed to be bigger" and how LifeLab needed to "get a dice that you can actually roll". Finally, the "boxing bag" was a source of many students' frustration, resulting in them stating how it needed to be "stronger" and "heavier" because “it almost broke” when they were using it. These small, but meaningful, changes could lead to a version of LifeLab that is more relatable and satisfactory to the students.

Sub-theme: The LifeLab Space

The students were also critical of the LifeLab space. During the focus groups, they mentioned how the room was “just white, and it is all boring and bland”. The students felt that it was important to “paint the room a nice colour” … “like a like red, yellow, rainbow or forest green”. Another student went a step further, and felt that each activity should be painted a specific colour: “every different section should be a different colour” or that the space should themed based on the most relevant holiday: “I feel if it is Halloween, you should put Halloween decorations, if it’s like Easter you should do an Easter theme, and if it is Christmas, do a Christmas theme”. Not only were the students critical of the LifeLab decor, but they also highlighted how the LifeLab space was too small. The students expressed the need to “make the room bigger” as it “was too cramped”.

Teacher Questionnaire

All three teachers completed the questionnaire and attended the focus group. The findings from the questionnaire are detailed below (Table 6.5).

Table 6.5. Teacher Questionnaire

Item	Teacher 1	Teacher 2	Teacher 3	Average
How would you rate the school-based element of the intervention?	3	4	4	3.66
How would you rate the LifeLab (DCU-based) element of the intervention?	5	5	5	5
How would you rate the intervention overall?	4	5	4	4.33
How prepared did you feel to deliver the school-based lessons?	2	4	4	3.33
How would you rate the resources that we provided for the lessons?	3	5	4	4
How would you rate the researchers contact with you?	5	5	5	5

Teacher Focus Groups

Following the RTA of the gathered data, three themes, with subsequent sub-themes were generated: (i) Positive elements of the LifeLab intervention, (ii) the implementation challenges, and (iii) suggestions for future scalability. Table 6.6 presents all themes and subthemes.

Table 6.6 Themes and Subthemes from Teacher Focus Groups

Theme	**Sub-theme**
Positive Elements of the intervention	The out-of-school experience
	The engaging nature of the LifeLab experience
	The importance of the lifelab facilitators
	The amount of time per visit
Implementation challenges	Difficulties with delivering the school-based content
	The re-shuffling of students mid-intervention
Additional suggestions for future scalability	Refining the school-based content
	Define a clear intervention map ahead of commencing intervention
	The number of LifeLab visits

Theme: Positive elements of the intervention

Sub-theme: The Out-of-School Experience

The teachers mentioned that the students really enjoyed the out-of-school element of the LifeLab intervention, whereby they had the opportunity to leave school for an afternoon to experience the LifeLab facility in Dublin City University. One teacher felt that “the best part” of the intervention was the fact that the students had “a trip to DCU (Dublin City University)” to “look around the stations (learning activities)” and “dip their toe into something different that links with other subjects, like SPHE (Social Personal Health Education), PE (Physical Education) and Wellbeing”.

The novelty of this element was also perceived positively, with one teacher enjoying the idea of the students being able to “see what they are learning in class in action”. Another highlighted how it was “completely different” to what the school would typically be able to offer “in the classroom”, and that “getting out of school and going down (to LifeLab) is what makes it real”.

Furthermore, the teachers referred to how the students were excited about their second visit to LifeLab after completing LifeLab 1. One teacher stated that “they were looking forward to going back down and that speaks volumes”, with another saying, “the biggest thing for me was that they had no problem going back”.

Sub-theme: The Engaging Nature of the LifeLab Experience

The teachers felt that LifeLab activities were interesting for the students, and that they appeared to engage very well with the experience: “I thought they really enjoyed it, they got really into it and were engaged”. One teacher appeared surprised at how well the students engaged, stating that they “thought they might be a little reluctant at the beginning” but instead they were “really engaged with it once they got stuck in…it was great”. The teachers felt that the students’ engagement remained throughout LifeLab experience. This was evident when they discussed how “there was never a station (learning activity) that you’d see the kids tune out” and that “they were never bored” during their time at LifeLab.

The teachers emphasised how the range of different activities in LifeLab contributed to the students’ engagement and enjoyment, with one teacher stating, “I thought there was a nice mix of activities, like they were being physical in one and then using their head in the next”. The importance of variety within each LifeLab visit, and between LifeLab 1 and LifeLab 2 was also expressed. One teacher mentioned how they felt the LifeLab visits “were very well done” and how they enjoyed the idea of “mixing up” the activities so that the students were not “going back down (to DCU for LifeLab 2) and doing the same thing over and over”. The teachers recommended that “whatever is developed going forward that there is always variety” and that the students “are always going back down to do something that they haven’t already”.

Sub-theme: The Importance of the LifeLab Facilitators

The teachers complimented the delivery of the LifeLab learning activities. Each LifeLab activity had a designated ‘facilitator’, who delivered the learning activity to the students. According to the teachers, the facilitators contributed heavily to the students’ LifeLab experience: “they were super people, really great”. Although the teachers felt that the activities themselves were impressive, it was “the person that was doing the activity” that “made the difference” and “really enhanced” LifeLab. The teachers also noted that the LifeLab facilitators “were really engaging with the kids” and “really provided the experience with “energy”.

Sub-theme: The Amount of Time per LifeLab Visit

When discussing the LifeLab experience, the teachers commented of the length of time the students spent in LifeLab per visit (LifeLab 1 & 2). The teachers mentioned that they felt the amount of time “was perfect” and that “anymore (time), you’d have been dragging it, but any less and they wouldn’t have gotten anything from it”. The teachers highlighted that they “wouldn’t change that (the time) at all” in fear of “losing them (the students)”.

The teachers also felt that the timings of the LifeLab visits “worked well” with the school schedule. It was mentioned that the school is “very set on time” and that the teachers felt “the kids must be back for twenty to four (end of school day), otherwise we would be giving them detention”. In addition, the teachers liked the fact that the LifeLab visits took place in the afternoon, rather than the morning as it might be difficult to get the students to “settle back into class” and may even take a “class or two” for them to do so.

Theme: Implementation Challenges

Sub-theme: Difficulties with Delivering the School-Based Content

The teachers highlighted that the content provided by the research team for the school-based element of the intervention was too difficult for the target audience. One teacher articulated this by saying “I thought it was totally over their heads…I would more use them (lessons plans and lesson material) as a guide, rather than anything else”, with another teacher stating, “we agreed that if you are aiming it at first years, it might be too much for them”.

In addition, the teachers felt that the content developed by the research team was not suitable for the class periods allocated, as per the student’s timetable: “it’s only forty minutes a week that we have them…so you end up cutting it all out” and that “realistically you would have to dedicate two, three or four classes to get it (some elements of the school-based intervention) done”.

Sub-theme: The Re-Shuffling of Students Mid-Intervention

During the intervention, the students in each class group were re-shuffled and grouped based on their academic abilities. This caused disruptions for both the students and the teachers, impacting their relationship and rapport. The teachers mentioned how this rearranging of students previously took place prior to the students starting their first year of post-primary education: “they used to be put in groups before they came to school but now, they come in and then they change after about six weeks”. The teachers highlighted that “a good bit of mixing goes on when the classes change”, which is worsened by the fact that some teachers might have limited contact time with the class group: “see SPHE is only once a week, so I have no relationship with the class myself”.

This issue was particularly pertinent during elements of the intervention that required the students to work in groups. The teachers highlighted that due to the re-shuffle, understanding the “group dynamic” was made difficult, which led to issues when attempting to match-up students for group work:

“When you’re putting kids into a group and you don’t know who matches with who, or who mixes well with who… that’s the issue I found, you spend nearly ten minutes putting them into a group and taking them out of a group because they just don’t work”.

To avoid this issue and allow for the teachers to develop a better relationship with the students ahead of the intervention, the teachers recommended that for future interventions take place “after Christmas” or at some point during the second half of the school year.

Theme: Additional Suggestions for Future Scalability

Sub-theme: Refining the School-Based Content

As previously mentioned, implementing the school-based content raised some issues for the teachers due to its level of difficulty. In order for the content to be feasibly delivered by the teachers and appropriate for the target audience, the teachers suggested keeping the school-based content “really, really simple and practical”. The teachers described how the tasks need to be clearly defined for them to be achievable. For example, when discussing the project-based element of the intervention, the teachers described how the students required clear guidance and “prescriptive” tasks:

“If we said to them go off and do a project on nutrition they wouldn’t know where to start or to end…they don’t know what to put into it, they don’t know what to look up… they just don’t know”.

This was further emphasised by another teacher who suggested that the students design "a simple poster or leaflet" as that would allow them to still "apply knowledge but it becomes a smaller and more manageable task". In addition, the teachers recommended using "surveys" or "practical tasks" to relate the learning back to their own lives and the lives of their peers. Specific suggestions included "tracking what they ate for breakfast", "step counts" and "measuring how many hours of sleep they get".

Sub-theme: Define a Clear Intervention Map Ahead of Commencing Intervention

The teachers also wanted the intervention to be clearly mapped out ahead of time as they felt that they were unsure of how long the intervention would run for and what was expected of them during it: "I think when we're doing it again, I would just love to know, and I think this is from everyone, is this is an eight-week programme or this is a six-week programme, and then after that you're done".

Another teacher added that they would like a "clear start and end point" and for the research team to articulate precisely the details of the intervention, such as "these are your lessons, these are your (LifeLab) visits, and by December or January you are finished". This would allow the teachers to plan accordingly and know their "timeframe" and "when they can get back to other SPHE stuff".

Sub-theme: The Number of LifeLab Visits

When discussing the visits to LifeLab, the teachers mentioned that they felt that one more visit to LifeLab would have enhanced the students experience of the intervention:

"I think three would be perfect, if you got one more visit out of them and did something different again it would be perfect".

Although the teachers felt "twice was lovely", they said that "three would be the magic number" to provide the students with "a full taster of it (LifeLab)". Furthermore, they stated that the students would be "very happy” to have “three visits over the four months”.

Reach and Dose Delivered

In total, 80 participants (82.5% of the total first year cohort) attended LifeLab 1 and 74 participants (76.3% of the total first year cohort) attended LifeLab 2.

The dose delivered is detailed in table 6.7. The teachers reported that the first three school-based lessons were delivered to all four classes, however, Teacher 3 did not deliver any of the final four lessons to either Class Three or Class Four. Teacher 2 and Teacher 3 delivered the first project-based lesson and the LifeLab 2 recap to their class groups but did not deliver the second project lesson nor the final showcase lesson.

Table 6.7 Intervention Delivery Checklist

Intervention Element	**Class 1 (Teacher 1)**	**Class 2 (Teacher 2)**	**Class 3 (Teacher 3)**	**Class 4 (Teacher 3)**
Introductory lesson (school based)	✓	✓	✓	✓
Vignette lesson (school based)	✓	✓	✓	✓
LifeLab 1 (attend)	✓	✓	✓	✓
All LifeLab 1 activities delivered	✓	✓	✓	✓
LifeLab one recap (school based)	✓	✓	✓	✓
1st project lesson (school based)	✓	✓	X	X
2nd project lesson (school based)	X	X	X	X
LifeLab 2 (attend)	✓	✓	✓	✓

All LifeLab 2 activities delivered	✓	✓	✓	✓
LifeLab 2 recap lesson (school based)	✓	✓	X	X
Showcase lesson (school based)	X	X	X	X

Delivery Fidelity

Table 6.8 highlights the fidelity of LifeLab 1 and LifeLab 2.

Table 6.8. LifeLab 1 & LifeLab 2 Intervention Fidelity

		Average score per activity												**Overall**	
Item	**Aligning Principle(s)**	**Physical Activity**		**Mental Health**		**Sleep**		**Social & Environ-mental factors**		**Food Choices**		**Substance Misuse**		**Mean**	
		LL1	**LL2**	**LL1**	**LL2**	**LL1**	**LL2**	**LL1**	**LL2**	**LL1**	**LL2**	**LL1**	**LL2**	**LL1**	**LL2**
Percentage of students that physically or verbally engage in the activity at least once?	Empowerment, participative	100%	100%	100%	100%	84%	100%	100%	n/a	100%	100%	n/a	100%	96.8%	100%
Percentage of students that physically or verbally engage in all aspects of the activity?	Empowerment, participative	100%	89%	100%	89%	68%	72%	95%	n/a	100%	100%	n/a	83%	92.6%	86.6%
(Likert scale 1-4)															
Students are given the opportunity to actively participate, input, engage?	Experiential experience, Empowerment, participative, Constructivist pedagogy focus	3.5	3.75	3.75	3	3	3	3	n/a	4	4	n/a	4	3.45	3.55
Is it clear that every voice is respected?	Equitable	3	3.5	3	2.75	2.5	2.75	2.75	n/a	3.75	3.5	n/a	3.75	3	3.25
Where appropriate, are students' health strengths acknowledged?	Strengths-based	2.5	3.25	2.75	2.75	2.25	2.5	3	n/a	3	3.25	n/a	2.75	2.7	2.9
To what extent is there evidence that the young people can relate to the learning activity content?	DEIS focussed, relatedness (SDT)	3.5	3.25	3.25	3.75	3	2.5	3.25	n/a	3.75	3.5	n/a	3.25	3.35	3.25
To what extent are students given the opportunity to explore the learning within the activity for	Autonomy (SDT), empowerment	3.25	3	3	2.75	3	3	2.5	n/a	3.25	3.25	n/a	3	3	3

themselves (or as a group)?															
To what extent are the students relating to their peers and the learning during the experience?	Relatedness (SDT)	3.25	2.75	3.25	2.25	2.75	2.5	3.25	n/a	3.75	2.5	n/a	2.25	3.35	2.45

During LifeLab 1 the students appeared to engage well with the learning activities, with only the sleep activity producing a score of below 90% in the two engagement measures. Overall, during LifeLab 1 the learning activities appeared to align with the core principles and theoretical constructs, with all but one scoring three or above. The items that scored the highest were those assessing if the activity provided the opportunity for students to participate, input, engage and participate (3.45) and if the activity allowed the students to relate to their peers and to the learning (3.35). The item that scored the lowest, however, was that assessing if the activities adopted a strengths-based approach (2.7).

Similar to LifeLab 1, the engagement scores for LifeLab 2 were high, however, the scores for the percentage of students engaging in all aspects of the activity (86.6%) was lower than the measure assessing those who engaged in the activity at least once (100%). Once again, the overall fidelity of LifeLab 2 was very high, with only two items overall mean scores reported as lower than three. These were items relating to strengths-based approach (2.9) and the measure of assessing whether the students were relating to their peers and the learning experience (2.45). The item assessing if the learning activity provided the students with the opportunity to engage and/or participate scored the highest in LifeLab 2 (3.55).

When comparing the fidelity of LifeLab 1 and LifeLab 2, although both reported high fidelity overall, there were some differences. The percentage of students that engaged in all aspects of the learning activities was lower in LifeLab 2 (86.6%) compared to LifeLab 1 (92.6%), with only one activity (food choices) scoring 100% in LifeLab 2, whereas three activities (food choices, physical activity, and mental health) scored 100% in

LifeLab 1. The measures for strengths-based approaches scored below three in both LifeLab 1 and LifeLab 2. This was the only item that scored below three in both version of LifeLab. The item assessing the students' opportunities to input, engage and participate was high in both LifeLab 1 (3.45) and LifeLab (3.55)2. LifeLab 2 (3.25) appeared to be slightly more equitable than LifeLab 1 (3), with the learning activities scoring higher on ensuring that all participants' voices were heard and respected. The measure for relatedness (the extent to which students relate to their peers and the learning) dropped in LifeLab 2 (2.45), when compared to LifeLab 1 (3.35).

Effectiveness

Table 6.9. Pre and Post Motivation to Adopt Healthier Behaviour Scores

Motivation Dimension	**Pre (n = 28) Mean (± SD)**	**Post-Intervention (n = 28) Mean (± SD)**	**Z**	**p-value**
Intrinsic Regulation	3.01 (±1.08)	2.88 (±.99)	-.908[b]	.364
Identified Regulation	3.17 (±1.17)	3.51 (±1.19)	-1.101[c]	.271
Introjected Regulation	2.54 (±1.15)	2.45 (±1.06)	-.115[b]	.908
External Regulation	1.86 (±.58)	1.87 (±.68)	-.024[c]	.981

b. based on positive ranks; c. based on negative ranks

The Wilcoxon Signed Rank Test revealed that there was no statistically significant change in the participants' intrinsic motivation (z = -.908, p = .364); identified regulation (z = -1.101, p = .271); introjected regulation (z = -.115, p = .908); external regulation (z = -0.24, p = .981) to adopt healthier behaviours after the LifeLab intervention.

Discussion

This study aimed to evaluate the acceptability, reach, dose delivered, fidelity and effectiveness of a nine-week, HL intervention for socioeconomically disadvantaged adolescents. Overall, the results indicated that the LifeLab experiences were perceived positively by the students and teachers. The school-based element received mixed reviews, with the teachers providing insightful feedback on the difficulties that they encountered when implementing the lessons designed by the research team. These difficulties impacted the delivery of elements of the school-based component of the intervention, but the fidelity and reach of the LifeLab visits were high.

The LifeLab intervention, however, had no statistically significant impact on the adolescents' motivation to adopt healthier behaviours, as measured by the adapted BREQ. This may have been due to a number of factors. One possible contributor may have been the reduced number of school-based lessons delivered. Some of the students in the intervention only received 50% of the intended lessons, severely decreasing the possible learning opportunities. One of the major issues the teachers faced when delivering the school-based lessons was the level of difficulty and volume of content provided for each lesson by the research team. To address this issue, the school-based component of the intervention needs to be adapted to suit the academic ability of all students in the target population. Although the research team co-designed the hands-on experiences of LifeLab 1 and LifeLab 2 with students from the targeted school (Goss et al., 2022; Smith et al., 2022), due to time constraints and other pressures on teachers and school principals, which were exacerbated by COVID-19, it was not possible to also co-design the school-based lessons. By involving the students and teachers in the design and development of the school lessons, the content may have been more appropriate for the students to understand and more realistic for the teachers to deliver, potentially resulting in a greater impact on the participant's motivation to adopt healthier behaviours. This further demonstrates the strong evidence supporting the use of participatory approaches in designing health interventions (Moore et al., 2019; Moore & Evans, 2017), particularly in schools (Reed et al., 2021) and in low socioeconomic populations (Coupe et al., 2018). Such approaches increase the likelihood of intervention relevance, implementation, and better outcomes (Craig et al., 2008a). Despite the school and the research teams' best efforts, this limitation reflects the pragmatic constraints on this real-world project. Moreover, Tomlinson (2005) argues that in order to effectively deliver and differentiate lessons for the target population, teachers are required to have an understanding of their students' level of knowledge, interests and learning profile. Based on this, and the information provided by the teachers around their difficulties in developing a rapport with the students so early in the semester due to the students changing class groups after six weeks, future LifeLab interventions with 1st year cohorts may be best implemented later in the academic year. This is particularly important as Pham (2012) identifies three general principles that underpin delivery and differentiation of lessons, all requiring a good relationship between the students and teachers. These principles include (i) creating appropriately challenging tasks, as students learn effectively when learning is moderately challenging; (ii) designing flexible groupings and classroom arrangements, allowing for productive collaboration, and providing the teacher with freedom to assist those who need it most; and (iii) providing ongoing assessments and scaffolding, providing the students with the opportunity to showcase their skills through a variety of techniques. Thus, by providing the teachers with adequate time to develop a strong relationship with their students, it enhances the potential for them to tailor the lesson plans to their students' profiles, and consequently increases the possibility of the lesson content positively impacting the participants' motivation to adopt healthier behaviours.

It must be acknowledged that research has demonstrated the difficulties in improving motivation to adopt healthier behaviours (Kelly & Barker, 2016), with systematic reviews assessing the effects of health interventions on behaviour change or health outcomes often conclude that both the interventions, as well as the effect size, were extremely heterogeneous (Lemmens et al., 2008; Ogilvie et al., 2007). In order to improve the effectiveness of health interventions to positively impact motivation, it is necessary to replicate and accumulate evidence across empirical studies (Michie et al., 2011), yet due to the complex nature of behaviour change interventions (Craig et al., 2008), this is not straightforward. Replication, accumulation, and application of evidence depend on published interventions adequately reporting their intervention content and delivery to allow for the identification of effective intervention ingredients (Michie et al., 2009). Despite this, intervention reporting often falls short, containing brief, imprecise, and broad descriptions of the intervention content and techniques (Michie et al., 2011). Although there are a wide range of factors that can influence the effectiveness of a complex health intervention, a key element that is often overlooked in the measurement and reporting of an intervention is the quality of intervention implementation (Craig et al., 2008; Moore et al., 2015, 2019). Implementation fidelity can provide valuable information in relation to the reliability and internal and external consistency of a behaviour change intervention (Bellg et al., 2004), with some stating that conclusive statements about an intervention’s effects cannot be made without attention to the delivery fidelity (Borrelli, 2011).

Overall, the level of implementation fidelity of the LifeLab visits were very high, with only the strengths-based approach principle scoring below three in both LifeLab 1 and LifeLab 2. Traditionally, health promotion approaches have focused on a risk model (Alex Linley et al., 2006; Evans, 2004), which concentrates on patterns of diseases, and how best to avoid them (McCuaig et al., 2013). Recently, there has been a shift away from this. One example being the new Health and Physical Education curriculum in Australia (McCuaig et al., 2013), which is underpinned by a salutogenically-grounded approach and focuses on the positive contextual, social, and individual variables that disrupt an individual developing risky behaviours and poor health outcomes (Zimmerman, 2013). Although LifeLab was intended to be strengths-based, the measure of fidelity suggests that the delivery of the hands-on element may have fallen slightly short on various learning activities. Using the Australian curriculum (McCuaig et al., 2013) as a guide to improve the design and implementation of LifeLab, the learning activities could further emphasise the promotion of healthy living rather than illness prevention; consider the role of the community, social dimensions, and local resources in healthy living; and highlight that health is not regarded as an end goal, rather a prerequisite for living a fulfilling life. On a practical level, this could be achieved by (i) designing activities that allow students to identify local positive resources that could inspire healthy living rather than focusing on reducing risk factors (McCuaig et al., 2012), (ii) employing further inquiry-based pedagogies (Burrows et al., 2013), such as an action-orientated assessment task, allowing the students to use their individual assets and competencies to problem solve, and (iii) encouraging and listening to the students' voices during each learning activity (Begoray et al., 2009). Adopting such pedagogies, not only places the students at the centre of the learning, but also develops crucial HL skills. By using a strengths-based approach in LifeLab and linking the learning with the participants' social and physical environment, the students can potentially develop their assets and resources so that they can functionally, interactively, critically engage and participate in society (McCuaig et al., 2013). Moreover, these additions to LifeLab would further allow students to move beyond the acquisition of functional HL (understanding of information) and develop bespoke interactive and critical HL, empowering the participants to take control of their own lives (Alfrey & Brown, 2013; Nutbeam, 2008). The high level of engagement, participation and acceptability of the LifeLab learning activities was evident based on the fidelity checklist and qualitative data obtained from the students and teachers. These findings indicate the value in adopting less traditional modes of health education. The students enjoyed the style of learning adopted during the LifeLab visits, commending the interactive elements (e.g., social & environmental factors and physical activity learning activity) and criticising the more mundane and theory-based activities (e.g., food choices learning activities). In particular, the students enjoyed the game-style elements, the competition, the incorporation of physical activity into the learning and the opportunity to practice mental health techniques, while the teachers commented on how they felt the variation across learning activities aided the engagement of the students. It has been highlighted that many public health initiatives attempting to develop health awareness and behaviour change through unidirectional communication, such as advertisements or educational booklets, are often ineffective (Ashfield-Watt, 2006; Kelly & Barker, 2016). In contrast, LifeLab offered a transactional and experiential learning style, whereby the students could interact with the learning through competitive, problem-based, and hands-on activities.

A constructivist and inquiry-based pedagogical approach underpinned the transactional and experiential learning style delivered in the LifeLab experiences. This adheres to the findings of a systematic review carried out by Nash et al., (2021), which reviewed school-based HL programs for children aged 2-16. The review's findings highlighted the importance of intervention delivery, specifically utilisng an approach, such as a constructivist approach, to support student HL competency development. The authors discuss the value in enacting a learning experience which harnesses the students' voice and provides them with an opportunity to bring their lived experiences to inform learning that is meaningful to them and their world. Furthermore, Yu et al., (2012) has urged educators to employ participatory learning pedagogy, recognizing that pouring information into young people as if they are a “passive vessel” is unlikely to result in the desired outcome. Instead, student empowerment and participation, through constructivist pedagogical approaches, as displayed in the LifeLab intervention, have been identified as crucial contemporary health promotion and student-orientated pedagogical ideals (Aira et al., 2014). In addition, the review by Nash et al., (2021) detailed the value in inquiry-based pedagogy, such as approaches which are action-orientated, involved critical thinking, reflective learning, and ultimately empowered young people to take control of their health. These approaches were included throughout nearly all LifeLab learning activities (see sppendix I & J), with the aim of providing an engaging educational experience for the students’ that supports contextual HL development.

The transactional and experiential learning style has been recognised as a viable method to support learning via the co-construction of understanding (Bay et al., 2012), with LifeLab in Southampton (Woods-Townsend et al., 2021) and LENScience in New Zealand (Bay et al., 2012) offering strong evidence for its use in developing HL in young people. Experiential learning, as showcased in LifeLab, is first-hand, sensory based learning, allowing for the participants to explore, touch, listen to, watch, dissemble and reassemble (Behrendt & Franklin, 2014). The process and benefits of experiential learning is summed up by Kolb’s (1984) model, theorising that experiential learning is a four-stage learning process. These stages include the participant having i) a new experience; ii) reflecting on the experience and observing it from many perspectives; iii) thinking and reflecting abstractly about the experience and learnings; and finally, iv) testing out or applying the new learning in a real-life situation (Kolb, 1984).

Furthermore, the setting in which hands-on element of LifeLab (the LifeLab visits) took place was positively perceived by the students and teachers. According to both parties, delivering the interactive element of the intervention in an out-of-school setting further enhanced the intervention. Experiential learning outside of the classroom increases interest, knowledge, and motivation in young people (Behrendt & Franklin, 2014). This form of education provides unique experiences that cannot be replicated in the classroom, allowing for students to assimilate a deeper learning and promotes social development (Lei, 2010). In addition, providing interactive health exhibits outside of the classroom allows for school-based content to accommodate new levels of understanding, promoting students to engage with concepts in a way that is often not possible in the typical school environment (Lei, 2010).

Not only did the students enjoy the style of learning in and the setting of LifeLab, but they also valued the content delivered, citing the impact the learning could have on them and their peers. For interactive learning experiences to be impactful and meaningful, it is recommended that they should be carried out in the context of the participants' personal, social, and cultural setting (Bay et al., 2012). This highlights the benefits of the extensive co-design process previously undertaken to develop a culturally and contextually tailored LifeLab experience with, and for, the targeted cohort (Goss et al., 2022; Smith et al., 2022). The LifeLab intervention, therefore, could simulate real-life health-related situations, potentially providing the participants with the opportunity to develop the necessary knowledge, understanding, critical thinking and application skills (all key HL competencies as per Nutbeam & Kickbusch, 1998) to navigate everyday circumstances.

Limitations

It is of note that this study was carried in the midst of the COVID-19 pandemic, a time when HL was more important than ever (Sentell et al., 2020). HL capacities allow individuals to be well-informed about public health recommendations in relation to COVID-19, and to act in ways to best reduce the associated risks of contraction and transmission of the virus (Paakkari & Okan, 2020). Critically, there was and is a major concern for health equity, with the greatest effects of the pandemic likely to fall on disadvantaged populations (Sentell et al., 2020). Fortunately, there were no school closures in Ireland during the time of this study (October 2021 – December 2021), but surges in the numbers of COVID-19 cases in the community affected rates of attendance in schools and consequently elements of the intervention. During our post-intervention data collection, there was a rise in case numbers resulting in many absent students. Consequently, the sample for the pre- and post-measures effectiveness measure was significantly reduced. Additionally, the adapted version of the BREQ employed had not been validated, but the research team felt it was the most appropriate and relevant measure given there is currently no suitable HL measure available for adolescents in this context. The adaptation may have impacted the tool's ability to measure motivation validly. It was not possible to track reach, fidelity, or student acceptability during the school-based element. Assessing these elements may have put additional strain on the school staff, which was already mounting due issues related to the COVID-19 pandemic. This was reflected in the limited student demographics gathered and reported within the paper. Although this information was requested by the research team before, during and after the study, the school principal did not provide such information, presumably due to COVID-19-related pressures. The authors acknowledge the value in gathering this information, particularly given the low socioeconomic cohort targeted. Furthermore, government guidelines recommended that all students wear protective face masks during school (which included LifeLab sessions). This may have impacted the participant's experience of the LifeLab intervention. Finally, as discussed within the manuscript, the school-based element of the intervention was not co-designed, unlike the LifeLab experiences. This was a direct result of COVID-19. The research team had intended to co-design all elements of the LifeLab intervention, however, due to the additional pressures that members of the school-staff were under, as well as school closures (as a result of nationwide and local COVID-19 lockdowns), this was not possible. For the school-based element of the intervention to be impactful, future research should look to involve the necessary stakeholders in co-designing the school-based lessons content and delivery.

Conclusions and Future Directions

This process evaluation set out to gain insight into the acceptability, reach, dose delivered, fidelity and effectiveness of the nine-week LifeLab intervention for low socioeconomic adolescents. The findings suggest that overall, the intervention was well received by the students and teachers, particularly the hands-on, interactive experiences. The teachers, however, highlighted some issues they faced when implementing the school-based lessons, including the level and difficulty of the content being inappropriate. This led to many of the school-based lessons not being delivered to the students. The reach and dose delivered of the intervention was high, but the intervention had no significant impact on students' motivation to adopt healthier behaviours.

Based on the findings from this process evaluation, the authors suggest that the following recommendations are made to potentially improve the acceptability, dose delivered and impact of LifeLab. Firstly, future versions of the LifeLab intervention should aim to co-design the school-based element and tailor it to the needs and academic abilities of the targeted cohort. The feedback provided by the teachers highlighted that the volume and academic level of the school-based content was not suitable for the context. A solution to address this issue would be to provide the students and teachers with an opportunity to co-create a curriculum that they feel would be suitable to their context, and subsequently increasing the likelihood that the content would be contextually relevant for the students, as well as practical for the teachers to deliver. It is also recommended that the LifeLab intervention takes place later in the academic year with this particular school. The feedback from the teachers highlighted their desire for the intervention to take place later in the academic year to allow for the teachers to develop a strong rapport with their class group ahead of the intervention delivery. By providing the teachers with an opportunity to develop a strong relationship with the students, it increases the likelihood that they can develop an understanding of the students' needs; pitch the learning to the appropriate level; and design flexible student groupings and classroom arrangements to allow for the optimal learning environment. Thus, by implementing the intervention later in the semester, it enhances the potential for the teachers to deliver lessons to suit the personalities and needs of the students, and consequently increase the potential impact of the educational content. The intervention should also ensure that a salutogenically-grounded, strengths-based approach is adopted to focus on the positive contextual, social, and individual variables of the participating students. Although the intervention evaluated in this chapter aimed to deliver an intervention adhering to this approach, the evaluation highlighted that some learning activities in the LifeLab experience may have fallen short. On a practical level, future versions of LifeLab should ensure that the student is placed at the centre of the learning and that there is an emphasis on designing activities that provide students with an opportunity to identify local resources that could inspire healthy living; incorporate inquiry-based-learning that allows the students to use their individual assets to problem solve; and ensure that the student voice is encouraged and listened to during each learning activity. Although the LifeLab visits were perceived positively by the students and teachers, additional co-design work is required to further refine logistical, practical, and contextual factors to enhance the experience for the students and ensure that the content stays relevant to the adolescents' ever-changing physical and social environment.

Chapter 7: Synthesis of Findings and Future Directions

Overview of the Thesis

The literature highlights that poor lifestyle behaviours are a major contributor to the growing NCD-related public health crisis (Akseer et al., 2020; Mendis et al., 2015). This problem is heightened in low socioeconomic populations due to their increased risk of initiating risky behaviours, even at a young age, leading to significantly poorer health outcomes (Lago - Peñas et al., 2021; Pampel et al., 2010). HL has been identified as one possible means to improve and sustain healthy behaviours (Nutbeam et al., 2018), with adolescence a time point where such appropriate health interventions can make a sustained and meaningful difference (Sawyer et al., 2012). Hence, the aim of this thesis was to develop, design and evaluate a school-based HL intervention for low socioeconomic adolescents.

This synthesis summarises the findings of the three research studies (chapters 4-6) presented within this thesis. It then draws on the collective findings of the three studies to discuss (i) the importance and impact of adopting a co-design approach and (ii) the need for developing an evidence-base programme for engaging health literacy experiences aimed at low socioeconomic adolescents. Finally in the future directions section, recommendations will be made in terms of i) professional development for the teachers, ii) co-designing the school-based element, iii) embedding the intervention into the formal curriculum of additional schools, iv) adopting a more holistic approach, v) Upscaling and evaluating the LifeLab intervention with additional schools.

Summary of Findings

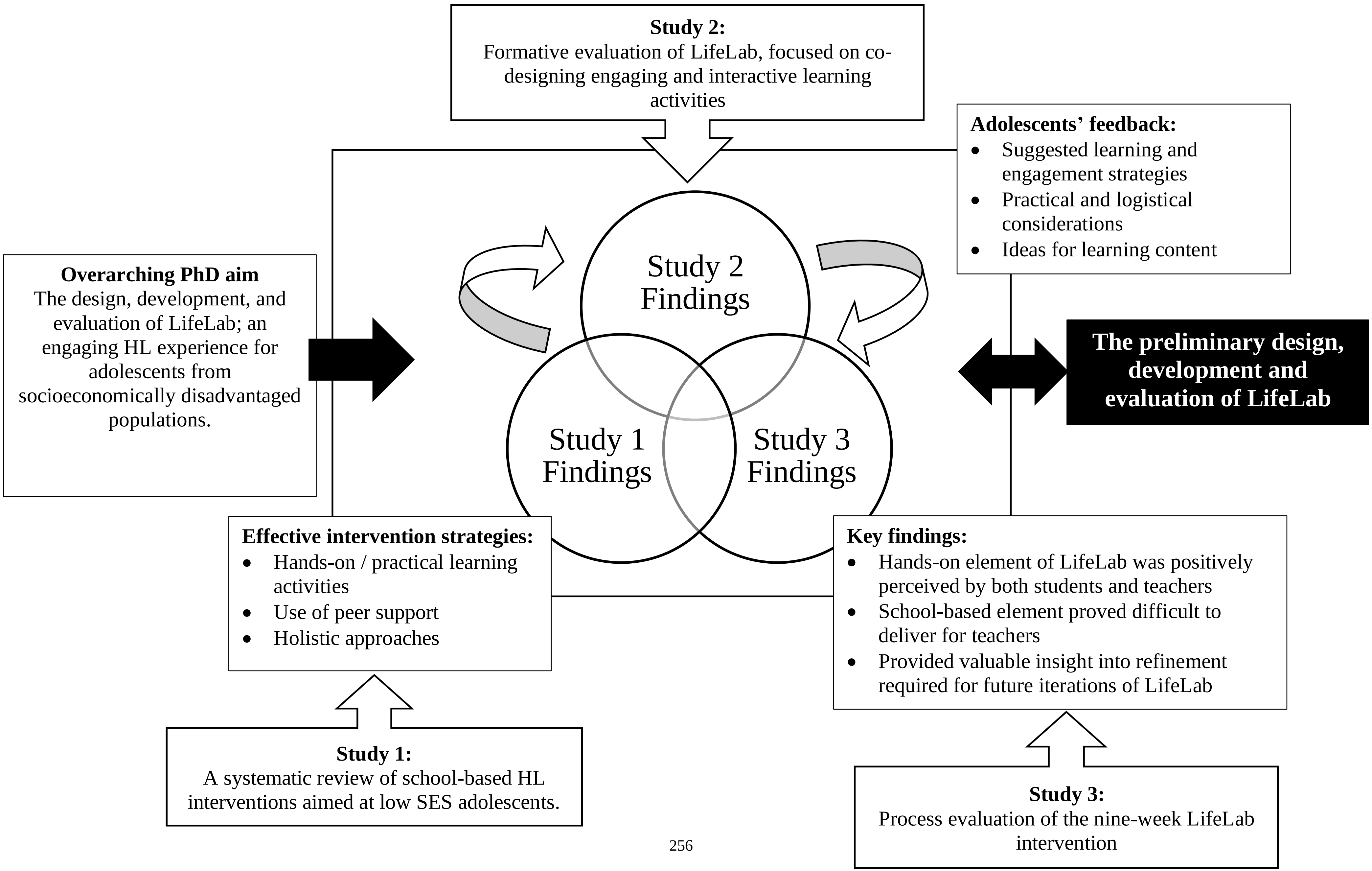
Study 1 (chapter 4) aimed to systematically review school-based HL-related interventions targeting socioeconomically disadvantaged adolescents and to identify effective intervention strategies for this population. This review highlighted the lack of school-based interventions in this cohort explicitly aiming to improve HL. The effective intervention strategies that were identified included practical or 'hands-on' learning activities, the use of peer support and holistic approaches that target the school environment, the parents or that link the intervention to the community.

Study 2 (chapter 5) aimed to co-design and formatively evaluate the specific LifeLab learning activities with, and for, socioeconomically disadvantaged adolescents in order to guide refinements and inform the intervention design and implementation. A series of co-design workshops were facilitated with adolescents from low socioeconomic populations to gather their perceptions, feedback, and suggestions on the activities. The study findings offer a valuable insight into young people's perceptions of HL education; specifically, methods which may be used to engage young people, practical considerations for implementing a HL intervention, and the health-related content that young people in this context feel is meaningful and important to learn about.

Study 3 (Chapter 6) was a mixed-methods process evaluation examining the acceptability, fidelity, dose delivered, reach and effectiveness of a nine-week school-based HL intervention for low socioeconomic adolescents named LifeLab. The findings highlighted that overall, the intervention was perceived positively by the students and teachers, particularly the two interactive out-of-school experiences. The teachers highlighted some issues with the volume and level of difficulty of the school-based content, impacting the number of school-based lessons delivered. The reach and fidelity of the LifeLab visits were high, but the intervention did not result in a statistically significant difference in the adolescents' motivation to adopt healthier behaviours. The evaluation provided valuable insight into the refinements and modifications required to enhance the efficacy of the LifeLab intervention.

Figure 7.1 below demonstrates the sequential nature of this project, whereby the outcomes of each study informed the design and direction of the next. As such, the findings from the systematic review contributed to the design of the LifeLab learning activities that were further developed and co-designed in study 2. Subsequently, the findings from study 2 informed the design and implementation of the hands-on element of the LifeLab intervention that were then implemented and evaluated in study 3. Furthermore, as this PhD is following on from research previously carried out, findings from previous studies also guided the design and development of elements of this project. A map of the how this PhD fits in with previous work was discussed previously in this thesis (figure 3.2).

Figure 7.1. Overview of Each Study's Contribution to the Overall Aim of the PhD



Major Contributions of this PhD

Research

This thesis has extended then current evidence in various ways. Firstly study 1, systematically reviewed the existing literature around school-based HL interventions targeting adolescents from low socioeconomic populations. In particular, the review was interested in collating the evidence on interventions focusing on five health domains, including: physical activity and sedentary behaviour; mental health and wellbeing; substance misuse; dietary habits; and sleep. Crucially, the study identified effective intervention strategies that can be used to guide and inform future school-based HL interventions targeting adolescents from low socioeconomic populations. Study 2, which focused on the co-design and formative evaluation of the LifeLab learning activities with young people from the targeted socioeconomically disadvantaged area, demonstrated an innovative methodology to (virtually) co-design school-based health interventions with post-primary students. Furthermore, the study identified (i) methods to engage young people from low socioeconomic populations in health education; (ii) practical and logistical considerations when implementing an engaging health intervention with low socioeconomic adolescents; and (iii) health-related content that is meaningful and valuable to socioeconomically disadvantaged adolescents. Study 3 used a process evaluation methodology to investigate the acceptability, fidelity, dose delivered, reach and effectiveness of a nine-week, school-based HL intervention targeting low socioeconomic adolescents. The evaluation highlighted factors that contributed to an acceptable out-of-school HL experience, and factors that inhibited the delivery of school-based HL lessons, from the perspectives of adolescent students' and post-primary school teachers from a low socioeconomically disadvantaged school.

Practice

The findings from this PhD can be used to inform the design and delivery of school-based health education, particularly interactive-style learning. Furthermore, this work has demonstrated that an iterative, co-design approach may produce school-based health interventions that are acceptable and contextually relevant to the target audience. The methodology adopted in this study can be replicated to develop contextually relevant health interventions in other settings.

Policy

The methodology adopted, and subsequent findings in the studies completed as part of this PhD, demonstrates the feasibility and importance of including young people in the health-related decision making about matters that affect their lives. Additionally, future iterations of the LifeLab intervention can potentially sit into and align with school-based health curricula (e.g., the 'Wellbeing Program' in Ireland), providing meaningful and novel learning for post-primary adolescents (discussed further in the future directions section).

The Importance and Impact of Adopting a Co-Design Approach

As with most disciplines, health sciences and health education research has mostly been carried out by conducting work 'on' people, or doing things 'to' them or sharing and explaining their experiences 'for' them (Smith et al., 2022). Recently, however, there have been calls for the use of public and patient involvement, whereby research is conducted 'with' or 'by' non-academic partners who have typically been excluded but could effectively shape, contribute to, and benefit from research (Leask et al., 2019). Although the concept of participatory approaches lacks clarity (Smith et al., 2022), the crux is to provide the relevant stakeholder (the experts) with the autonomy to guide and drive the key decision making processes (Williams et al., 2020). Given the complexity of school systems, their environment, and often the young people attending, the involvement and input from the targeted adolescents, when developing a school-based health intervention is particularly pertinent (Reed et al., 2021).

The difficulties in adopting a truly co-design approach must be acknowledged, however. Although the aim of participatory research is to adopt an egalitarian approach, which creates a level playing field for academic researchers and non-academic stakeholders (students and teachers) and allows co-researchers to become equal partners in the process rather than 'subjects' (Rose, 2018), this dynamic can be difficult to achieve. There are well-founded concerns that some participatory research fails to balance these power relations between the academic researchers and the co-researchers, compromising the potential of a participatory approach to achieve greater equity (Egid et al., 2021). Throughout the research process adopted within the studies detailed in this thesis (as well as the foundational research), every attempt was made to ensure power imbalances did not exist or to reduce them as much as possible. In order to create a non-threatening and relaxed environment, the students were constantly reminded that they were the experts in this situation and the value of their input was highlighted; the research process and aims were discussed in detail with all participants; the young people were always asked to use first names to address the academic researchers, in an attempt to remove the typical teacher and student dynamic; light hearted and interactive activities were carried out before, during or after the data collection; and academic researchers attended and took part in many non-research related activities in the school and the surrounding environment to develop a healthy rapport with the students and teachers (e.g., school sports days, clean-up days in the community and career fairs). Although these techniques, many of which are recommended by Egid et al., (2021), may have helped to remove some perceived power imbalances, it was very difficult to remove all. For example, during some of the online co-design workshops in study 2, due to school safeguarding policies, a member of staff (typically a teacher) was required to be present at all times. This may have interfered with the discussions in the workshops, particularly the students' engagement and the input on potentially sensitive topics. Future research carried out as part of the wider HL project will aim to evaluate these power dynamics through transparent discussions with all stakeholders and, if necessary, adopt alternative approaches to gather data (e.g., Photovoice), as recommended by Egid et al., (2021). Nonetheless, the findings from this PhD highlights the benefits of adopting a participatory approach, whereby academics and students worked together in order to achieve a shared goal of designing and developing a school-based HL experience that is contextually relevant and meaningful to low socioeconomic adolescents.

Co-design work carried out prior to the studies completed in this PhD identified key HL-related strengths and weaknesses (Goss et al., 2021); health areas that required addressing; and potential capacity building actions that could be incorporated into health interventions (Goss et al., 2022). The findings from these studies, along with evidence gathered from the literature in Study 1 (Smith et al., 2021), provided a starting point for Study 2. Based on the collated data from the aforementioned studies (Goss et al., 2021, 2022; Smith et al., 2021), the structure of the LifeLab experience and the specific learning activities were preliminarily designed (see linking section between chapter 4 and 5) by the project team to allow for input and refinements from the targeted adolescents. The value in using a co-design methodology was demonstrated in Study 2, which aimed to gather the perceptions of low socioeconomically disadvantaged adolescents on the specific LifeLab learning activities in order to refine and prepare the activities for the next stage of the intervention development. The findings from this qualitative study offered insightful and constructive information on young people's perceptions of health education, including guidance on how adolescents would like to learn; what they would like to learn about; and the practicalities of delivering an acceptable school-based health intervention. Given the difficulty in designing effective school-based health interventions (Langford et al., 2014), with many falling short due to a lack of alignment with the core objectives of the school and health issues of the attending students (Evans et al., 2015; Humphrey et al., 2015), Study 2 has added to the evidence-base by detailing innovative methods to involve young people in the design of a complex school-based health intervention in order to develop interventions that have the potential to tackle contextual health concerns. The findings from this study were not only invaluable in preparing for the next phase of the research (Study 3), but, more broadly, the methods and findings can be used to inform and guide future health interventions targeting similar cohorts. Similarly, Study 3, which detailed the findings of a process evaluation of the nine-week LifeLab intervention, reinforced the benefits of adopting a co-design approach. The LifeLab learning activities, which were refined and tailored based on the information provided by the participants in the co-design workshops in Study 2, were positively perceived by both the students and the teachers. The qualitative and quantitative data analysed as part of the evaluation clearly demonstrated the high level of acceptability of the hands-on activities, with many of the students and teachers citing specific engagement strategies that were suggested by participants in study 2 as key factors that contributed to an enjoyable and engaging experience in LifeLab (e.g., the use of competitive elements, wide variety of activities, game style-learning). In a recent study (Goss et al., 2022) with students and teachers from the same context as those in study 2 and 3, it was highlighted that the students often did not value health information discussed in the school and, therefore, it did not have any impact on their knowledge acquisition or health behaviours. A crucial factor when aiming to develop health knowledge through education in young people, is to consider how students want to learn and what they want to learn about (Fretian et al., 2020; Goss et al., 2022). Providing the students with the opportunity to design and develop the specific health content covered in the LifeLab experience and the mode of delivery of this content, resulted in a highly engaging and acceptable educational experience, increasing the potential for impacting the HL levels of the participants. It must be noted, however that other important stakeholders, such as the teachers in local socioeconomically disadvantaged schools were not involved in the co-design of the LifeLab learning activities due to time constraints and the pressures applied as a result of the COVID-19 pandemic. The authors feel that including the teachers within the co-design process may have added value in designing appropriate learning strategies and highlighting specific health issues within the context. This limitation is acknowledged, and future research will be sure to include the teachers in all co-design processes.

An important finding from Study 3, which was highlighted by the teachers, was that much of the school-based content was not suitable for the academic abilities of the targeted students. Due to time constraints and increased pressures on the teachers and school principals, mainly explained by issues related to the COVID-19 pandemic, it was not possible to co-design the school-based element of the LifeLab intervention as intended. Given the impact of involving young people in designing the interactive learning activities completed during the LifeLab visits, it is reasonable to suggest that co-designing the school-based lessons with the students and teachers may have resulted in lesson content and structure that were more suitable for the students' abilities and, therefore, more realistic for teachers to deliver. Unfortunately, this limitation of the research study reflects the realities of this real-world intervention. By trialling the school-based material during the intervention implementation and gathering the perceptions of it, however, provided an opportunity to obtain practical and important feedback that will inform the development of the next iteration of the LifeLab intervention.

Nonetheless, this PhD highlights the value in using methodologies that do not solely base the development of a health intervention around an academic theory, instead also providing the participants with opportunities to ensure that the intervention is meaningful to their context, and ultimately is equity driven and sustainable. By employing a 'bottom-up' approach throughout with adolescents from low socioeconomic backgrounds, it provides scope for the young people to design an intervention that has the potential to tackle real-life health issues that the participants have identified and feel are prominent in their social and physical environment (Craig et al., 2008). Given the impact of the environment on an individual's HL (Sorensen et al., 2012), it is crucial to ensure that HL-related educational experiences, such as LifeLab, are applicable to the context of the participants, allowing participants to develop the necessary knowledge and competencies to navigate their own socioenvironmental health issues. This is particularly important when working with low socioeconomic populations, as interventions targeting, but not specifically designed for these cohorts often result in poor engagement, making little impact and potentially even widening health inequalities (Coupe et al., 2018). The findings presented in this thesis demonstrate that a co-design approach is a possible method to develop an intervention that is acceptable and contextually tailored to the targeted participants.

Developing an Evidence-base for Engaging Health Literacy Experiences Aimed at Low Socioeconomic Adolescents

Research has highlighted the difficulties in developing effective health interventions for young people, with school-based health and HL interventions targeting adolescents showing inconsistent findings (Durlak et al., 2011; Langford et al., 2014; Smith et al., 2021). Although one possible reason for this, which was discussed previously, is a lack of alignment between the intervention, the practical application and the philosophical fit of the targeted school (Evans et al., 2015; Humphrey et al., 2015). Another reason that has been suggested relates to the methods employed to deliver the educational content. As many interventions use instructional approaches, whereby information is simply provided to the adolescent participants, some have posited that for an intervention to be impactful it requires a more engaging design, with less of a traditional didactic approach (Dahl et al., 2018; Woods-Townsend et al., 2021; Yeager et al., 2018). This is reaffirmed by experts in behaviour change, who suggest that the provision of information alone is not enough to impact lifestyle choices (Kelly & Barker, 2016).

Thus, this PhD aimed to design, develop and evaluate a novel and authentic HL experience, incorporating modes of learning that are both supported by the literature and were co-designed by the participating young people. As a result of the rigorous and evidenced-based design process (Goss et al., 2021, 2022; Smith et al., 2021) (which has been detailed throughout this thesis), the LifeLab experiences consisted of a range of contextually relevant interactive learning activities in an out-of-school setting. This experiential-style pedagogical approach has been modelled by LifeLab in Southampton, an innovative, hands-on, science-based approach targeting adolescent's HL through scientific knowledge targeting human biology, lifestyle behaviours and critical thinking (Woods-Townsend et al., 2018). Findings from a RCT of LifeLab in Southampton, highlighted the impact of such an experience, with the adolescents who took part in the LifeLab program increasing their theoretical HL at a 12-month follow up (Woods-Townsend et al., 2021). Although, the findings from the process evaluation in this project (Study 3) did not report a statistically significant impact on the participants' motivation to adopt healthier behaviours, they did highlight the students' high level of engagement in the interactive learning activities, their enjoyment of the educational experience and their willingness to return to LifeLab in the future. Furthermore, the teachers also commended the novel interactive experience, in particular the engaging and educational nature of the LifeLab visits.

These findings, notwithstanding the refinements suggested by the students and teachers, demonstrates the potential impact of a HL intervention, containing a bespoke out-of-school, interactive HL experience developed to address the contextual health issues faced by socioeconomically disadvantaged adolescents. This is in line with research that has demonstrated the benefits of moving away from unidirectional learning (Ashfield-Watt, 2006; Kelly & Barker, 2016), instead facilitating more experiential-style learning experiences, providing adolescents with the opportunity to learn via the co-construction of understanding (Bay et al., 2012). By adopting an extensive co-design approach throughout, the LifeLab learning activities were tailored to the needs and wants of the participating adolescents. This, firstly, contributed to the students' engagement and enjoyment of the experience and, secondly, ensured that the educational content was relevant and applicable to young people's lives. This is paramount when it comes to the use of interactive learning activities, as it has been demonstrated that science- and health-related learning experiences, which are based on an individual's personal, social and cultural experience and setting, have the potential to enhance health-related knowledge and understanding (Bennett et al., 2006; Lemke, 2001), empowering young people to deal with day-to-day health-related life events and, consequently increasing the likelihood of positive behaviour change (Woods-Townsend et al., 2018).

Furthermore, this thesis highlighted the benefits of hosting an engaging health intervention in an out-of-school setting, with both the teachers and students positively perceiving the novelty of leaving the school to complete a learning experience. Experiential-style learning, which is set outside of the school, can often lead to increased knowledge, motivation and interest in young people (Behrendt & Franklin, 2014). LifeLab provided a unique experience that could not be replicated in a classroom, providing students with the opportunity to develop a deeper learning on relevant health areas, develop social skills and engage with content and concepts in a way that would not be possible in a typical school environment (Lei, 2010). Such authentic out-of-school experiences can have a memorable impression on adolescents, potentially resulting in the knowledge tracking through to adulthood (Braund & Reiss, 2006; Grace et al., 2012; Resnicow et al., 2000; Smith et al., 2021).

Instrumental to the development of the concept of HL was Nutbeam's (2000) contribution, which distinguished between basic functional HL, interactive HL and critical HL. Critical HL can be thought of as a higher level cognitive ability as suggested by McLaughlin & DeVoogd (2004). If HL is the ability to access, understand, appraise and apply health information, then critical HL is a higher order process that can be developed through education to critically appraise health-related information (Sykes et al., 2013). Developing critical HL is crucial to empowering individuals to become aware of health issues, participate in critical dialogue and become involved in decision making for health (Zarcadoolas et al., 2003). Despite the clear rationale for developing critical HL (Paakkari & Paakkari, 2012), and the strong advocacy for the inclusion of critical HL in formal education of young people (Paakkari & Paakkari, 2012; Peralta et al., 2017; Ryan et al., 2012), critical HL has been a neglected domain of HL (Peralta et al., 2017; Sykes et al., 2013). If we are to develop skilled, knowledgeable, capable and motivated adolescents who have the ability to make healthy choices within the complexities of their social and physical environments, then critical HL or the promotion of adequate thinking skills should be the emphasis (Peralta et al., 2017; Ryan et al., 2012). Sykes et al., (2013), suggested that the lack of critical HL education is predominantly due to the traditional structures and functionings of schools. In addition, recent research has found that most school-based HL programs focus on specific health risk behaviours and few provide learning opportunities for young people to develop a critical understanding of health behaviours more generally and how socioenvironmental factors influence them (Chinn, 2011; McCuaig et al., 2012; Peralta & Rowling, 2018; Sykes et al., 2013). LifeLab, however, aims to facilitate a more holistic and HL encompassing learning opportunity, whereby participants can simulate real-life situations, providing the opportunity to develop the necessary knowledge, understanding, critical thinking and application skills (all key HL competencies as per Nutbeam, 2000) to navigate everyday circumstances. Many of the LifeLab learning activities are centred around contextual PBL, the goals of which overlap with those of HL development, where the development of higher order skills (e.g. comprehending, reasoning, critical thinking and application) are critical (Sorensen et al., 2012). Moreover, given the self-directed style of the PBL at LifeLab, which allows students to reflect on their previous experiences, develop potential solutions with peers and advance their soft skills (e.g., the mental health and wellbeing learning activity in LifeLab 1), it appears a viable method to educate young people on real-world health situations.

It must be noted that the LifeLab intervention had no statistically significant impact on the participants' motivation to adopt healthier behaviours, reaffirming the difficulty in eliciting behaviour change from health interventions (Kelly & Barker, 2016; Langford et al., 2014; Ogilvie et al., 2007). Although, there may have been many contributing factors leading to a lack of positive change, such as the difficulties faced by teachers when delivering the school-based content and the intervention timing coinciding with the re-shuffling of the students' class groups, the findings from the studies included within this thesis will provide a platform from which the LifeLab intervention can be refined and further developed to potentially improve the impact on future participants' levels of motivation to adopt healthier behaviours. Moreover, given that the LifeLab intervention aims to develop the HL of adolescents from socioeconomically disadvantaged backgrounds, it is critical that changes in HL levels are included as an outcome measure to assess effectiveness in future iterations of the intervention. To do so, appropriate adolescent HL tools are required, with recent research highlighting the dearth of applicable tools currently available (Guo et al., 2018; Ormshaw et al., 2013). Many of the tools commonly adopted in adolescents do not measure all areas of HL (functional, interactive and critical HL), and are often adapted versions of adult-focused tools (Guo et al., 2018). Many have argued that tools which have been adapted from adult versions are inappropriate given that HL in adolescents is distinct from adult HL, and therefore, tools need to be purposely developed to ensure their relevance and applicability to the adolescent population (Domanska et al., 2018; Spillane et al., 2020). For these reasons, HL was not used as an outcome measure in study 3. There is currently a research group based in Ireland, that is using a grounded co-design approach to develop an adolescent HL questionnaire that will serve the context and needs of young Irish people (Spillane et al., 2020). This research will allow for the gathering of valuable HL data that can objectively measure the effects of interventions, such as LifeLab. Furthermore, such a tool can be used to provide a clear picture of the current HL landscape in adolescents, and identify the strengths and weaknesses of a cohort, which can be used to inform the development and tailoring of the LifeLab intervention, as well as other HL programs. Through the design, development and evaluation of an interactive HL experience carried out as part of this thesis, a strong evidence-base has been created for future versions of LifeLab, but also for interventions aiming to develop an engaging and educational experience with young people from low socioeconomic populations. The implications for practise section below details the numerous recommendations that have emerged from this PhD.

Implications of the PhD's Findings

Overarching Intervention Strategies

The findings from the PhD have highlighted the potential benefit of adopting specific overarching HL intervention strategies with adolescents from low socioeconomic populations. These include implementing hands-on or practical learning components; the use of peer support; adopting holistic approaches that not only include an educational component, but also target the school environment and engage with families or community; and including out-of-school experiences as part of a HL intervention.

Specific Learning Engagement Strategies

Specific engagement strategies that could sit within a HL intervention were also identified, including incorporating healthy competition; interactive tasks; problem solving; game-based learning; and offering a variety and choice within and across learning activities.

Practical Considerations

The practical considerations identified within the study 2 and study 3 include limiting individual learning activities to 10 – 30 minutes to avoid participants losing interest; if adopting group-based activities, ensure that the groups are limited to 3-5 participants per group to facilitate an optimal learning environment; offer achievable but challenging learning tasks; and ideally use an aesthetically and visually appealing setting.

Educational Content Considerations

In terms of the educational content, the studies included within this thesis recommend that the learning within a HL intervention targeting adolescents from low socioeconomic populations, should be relatable and applicable to the participant's social and physical environment; include learning around the influence of social media on young people; and consider the impact of lifestyle behaviours on short- and long-term health.

Factors to Avoid

Finally, the findings from this thesis also highlighted some factors to avoid in this context. These include repetitive learning activities and tasks; overly confusing and intricate elements within the learning activities; and activities devoid of interaction, such as traditional didactic learning.

Future Directions

Although the findings from this PhD are noteworthy, and significant progress was made in relation to developing the LifeLab intervention, the process evaluation identified a number of areas that require future research and development. These include: (i) professional development for the teachers, (ii) co-designing the school-based element of the intervention, (iii) embedding the intervention into the formal curriculum, (iv) adopting a more holistic approach and (v) co-design and evaluation of the LifeLab intervention with additional schools.

Professional Development for the Teachers

Although HL interventions targeting young people in school settings is emerging, albeit slowly, research studies focusing on teachers' capabilities to teach and develop students' HL are sparse. Of the few studies carried out, it has been suggested that teachers' HL levels, HL beliefs, their attitudes towards teaching HL and their confidence in their ability to teach HL are strong predictors of HL teaching intentions (de Buhr et al., 2020; Lai et al., 2018; Nash et al., 2020; Peralta et al., 2021). Furthermore, research has shown that teachers report that they want and need HL-related professional development in order to develop their HL capabilities, pedagogies and school approaches (Goss et al., 2022; Nash et al., 2020). This evidence, along with the findings from the process evaluation of the LifeLab intervention (Study 3), demonstrating the weaknesses of the school-based element, highlights the need for teacher professional development delivery as part of the LifeLab intervention.

Co-designing the School-Based Element

As highlighted in the process evaluation chapter (Study 3), the school-based element caused some issues for the teachers, particularly the volume and academic level of the lesson content. In order to ensure that future versions of the LifeLab intervention include school-based lessons that are practicable for the teachers to deliver, it is recommended that the lesson structure and content are thoroughly co-designed by the students and school staff. Adopting such an approach increases the likelihood of intervention relevance, implementation and better outcomes (Craig et al., 2008; Reed et al., 2021).

Embedding the Intervention into The Formal Curriculum of Additional Schools

Despite the WHO publishing a HL report (WHO, 2014) recommending the strengthening of HL of school-aged children by including HL as a core component of national curriculum and adopting a whole school approach, only schools in Australia, the USA and Finland have addressed HL as part of a holistic school health promotion approach (Peralta et al., 2021). Given the reach of school-based education, including HL as a core component on the national curriculum increases its significance and role in contributing to the holistic development of young people (Alfrey & Brown, 2013; Macdonald, 2013). In the Irish context, a recent curriculum reform may be timely to present an opportunity to integrate the LifeLab intervention within the Junior Cycle education. A new ‘Wellbeing’ framework was introduced for post-primary schools at Junior Cycle in 2016, with a view to providing each school with autonomy to design their own health program which reflects the needs and resources of the school. Although teachers recognise the necessity of an impactful and educational curriculum, they have expressed the need for support and resources to help align and implement their curriculum with the ‘Wellbeing’ framework, whilst reflecting their school’s context (Goss et al., 2022). The delivery of the

LifeLab intervention was trialled as part of the ‘Wellbeing’ curriculum in Study 3, highlighting that a refined version of the intervention may be a viable HL intervention to embed within the ‘Wellbeing’ framework of additional schools of a similar demographic in order to deliver health education that meets the needs of the school and aligns with the curriculum requirements.

Adopting a More Holistic Approach

As adolescents’ HL is influenced by multiple individual, interpersonal, societal and environmental factors (Paakkari & Okan, 2019), in isolation, the use of a curriculum-based approach to influence HL and subsequent health behaviours may not be enough (Langford et al., 2014, 2015; McCuaig et al., 2012; Peralta et al., 2021). It has been recommended that school-based interventions use a systems-based approach that acknowledges the complex interactions between the need to promote HL at various levels (Langford et al., 2014). Although the LifeLab intervention, particularly the two LifeLab visits, aimed to be contextually relevant, with the learning activities focused on tackling typical health issues faced by the participant cohort, the intervention made no explicit links to the school’s community, the adolescents’ parents, nor did it specifically target the ethos and school environment. This limitation was a result of the implications of the COVID-19 pandemic, impacting the intervention development and contact with the school, however, future iterations of the LifeLab intervention should aim to adopt a more holistic approach (Langford et al., 2014), encompassing not only a curriculum-based approach, but also focusing on improving the health-related environment of the school and engaging with the local community (Smith et al., 2021). Previous research with this cohort has identified potential solutions that could be adopted to create a more holistic approach (Goss et al., 2022), however, it is recommended that further co-design work be carried out to ensure their acceptability and build on these findings.

Upscaling and Evaluating the LifeLab Intervention with Additional Schools

As per the MRC's framework, interventions should be systematically developed and evaluated, starting with a series of pilot studies, moving towards an exploratory trial and then a definitive evaluation (Craig et al., 2008). Upon refining the LifeLab intervention based on the findings of the evaluation studies included within this thesis, the next phase of intervention development requires further co-design with a wider group of stakeholders to ensure that the intervention's elements are transferable and acceptable to other low socioeconomic schools. Subsequently, a crucial next step in the development of the LifeLab intervention is to assess the impact of the strategies employed and the overall intervention. In line with the work of LifeLab Southampton (Woods-Townsend et al., 2021), a large scale RCT is required to determine the impact of the LifeLab intervention on HL levels and on health behaviours (specifically those targeted: food choices, physical activity, substance misuse, mental health and wellbeing, sleep) of low socioeconomic adolescents. Given the novel and thorough design of the LifeLab intervention, it is important to evaluate if it is improving the health behaviours and HL levels of the targeted young people, particularly given the lack of HL-related interventions targeting low socioeconomic adolescents (Smith et al., 2021) and the inconsistent impact of school-based health interventions (Moore et al., 2015).

As discussed previously in this chapter, however, there are numerous issues with measuring HL in adolescents due to the limitations of the existing tools (Domanska et al., 2018; Guo et al., 2018; Ormshaw et al., 2013; Spillane et al., 2020). Future versions of LifeLab should aim to use the tool currently being developed by the project's partners in

University College Dublin (Spillane et al., 2020), which has the potential to provide an appropriate and contextually relevant method to measure the HL levels of adolescents from this cohort. This tool is scheduled to be ready for use in 2023. Therefore, specific measures may include but are not limited to:

- Health Literacy: Context specific tool developed by the research team's partners in University College Dublin. It is currently under review and will be available for use by September 2023
- Risky behaviours such as adolescent alcohol, tobacco and illicit drug use: Questions taken from the HBSC cross national surveys (Inchley et al. 2018).
- Physical activity: Assessed via the PACE+ questionnaire (Prochaska et al. 2001).
- Leisure screen time: Assessed using the Questionnaire for Screen Time of Adolescents (QueST) (Knebel et al. 2022).
- Dietary behaviour: Assessed via the Adolescent Food Habits Checklist (Johnson et al. 2002).
- Mental health and wellbeing: Assessed via the KidsScreen 27 (Ravens-Sieberer et al. 2007).
- Sleep: Assessed via the Pittsburgh Sleep Quality Index (de la Vega et al. 2015).

A Final Word

To summarise, this thesis has provided a unique approach to developing a HL intervention with, and for, socioeconomically disadvantaged adolescents. By using the existing literature and working with key school students and teachers, an authentic, engaging and novel HL experience was designed, developed and evaluated. Importantly, this research provides a platform from which future versions of the LifeLab intervention, as well as other HL interventions, can be developed to provide young people with the necessary capabilities and skills to navigate their own health. Although the LifeLab intervention is at an early stage of development, it has the potential to be an effective means to empower young people to take control of their own health. It is crucial that future studies aim to build on these findings to further develop the intervention and enhance its acceptability and impact. Finally, it is hoped that this body of work has demonstrated the potential of participatory approaches, not only for HL interventions, but as a strategy to tackle complex public health issues more generally.

Reflections

From a personal perspective, this research process has been an incredible experience, albeit a challenging one. From my first day as a PhD student, where I attended a meeting with the wider project team and a leading member of the WHO, I was challenged, but ultimately, I was provided with opportunities to learn – these opportunities continued throughout my PhD journey.

From an intellectual standpoint, I have developed my knowledge of health literacy and the importance of targeting young people to reduce the burden of chronic illness. My previous studies, particularly those carried out in my masters (MSc Clinical Exercise Physiology), focused mainly on using lifestyle changes as a form of treatment for chronic diseases, however, the work carried out during this PhD has highlighted the impact of using innovative forms of education to prevent the establishment of poor lifestyle habits in individuals.

Due to the nature of this project, I was forced to move away from my overly meticulous ways, and instead developed the ability to adopt a pragmatic approach to research and practise. This shift in mindset moved me away from constantly attempting to create the theoretically 'perfect' situation or outcome, and instead, allowed me to make key decisions that were more realistic and would be of benefit to the intervention development, research output, but ultimately the participating students.

From a methodological point of view, I enjoyed developing my qualitative skillset – a method of research I had not had much exposure to prior to starting the PhD. My background in exercise physiology revolved mostly around quantitative research, however, the research undertaken during this PhD has provided me with a newfound appreciation for the value in adopting qualitative measures. Such methods allowed me to see the world from the eyes of the adolescents' and provided me with the opportunity to help them to create a meaningful (and hopefully impactful) learning experience for themselves and their peers. This process, and in particular, seeing the students engage and enjoy the LifeLab experience was wonderfully fulfilling for me.

Although, at times the writing of this thesis has been a tireless task, it has been an exhilarating and proud process. It has allowed me to document the hard work that I, and the rest of the research team, have put in over the past number of years - I just hope that my writing skills does that justice.

To conclude, completing this project has been an amazing experience, and one I will be forever grateful for. It has not only provided me with an opportunity to work with gifted researchers, practitioners, teachers and young people, but has also provided me with a medium to express my passion for health promotion, particularly in those less fortunate.

Thank you for taking the time to read my work,

Craig.

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Appendices

Appendix A: PICO Table

	Inclusion Criteria	Exclusion Criteria
Population	Adolescents with a reported mean age between 12 and 16 years from a socioeconomically disadvantaged (or equivalent) background.	Mean age not between 12-16 or special populations (e.g., children with learning difficulties, pregnant adolescents, exclusively obese individuals, or those with a specific health condition).
Intervention	The implementation of an intervention related to health literacy (increases health knowledge, understanding, awareness, motivation, confidence) in at least one of the following areas physical activity, sedentary behaviour, dietary habits, sleeping habits, mental health or substance abuse.	The intervention did not include an educational element or a component targeting health literacy (increases health knowledge, understanding, awareness, motivation, confidence).
Context	School-based interventions, interventions that could be feasibly implemented in a school setting, or interventions that could be linked to a school curriculum.	Book chapters, case studies, student dissertations, conference abstracts, review articles, meta-analyses, editorials, protocol papers or systematic reviews.
Outcome	Aimed to increase health knowledge/comprehension, understanding, behaviour, value, wellbeing, motivation, self-efficacy or self-monitoring in relation any of the following domains: physical activity, sedentary behaviour, dietary habits, sleeping habits, mental health or substance abuse	Outside of the targeted health domains.
Study Design	Published in English and in a peer-reviewed journal	Systematic review, meta-analysis or full text not available.

Appendix B: Search Strategy

((((health[Title/Abstract] OR “health literacy”[Title/Abstract] OR “health knowledge”[Title/Abstract] OR “health competenc*”[Title/Abstract] OR “health understanding”[Title/Abstract]) AND (“physical activity”[Title/Abstract] OR exercis*[Title/Abstract] OR sedentary[Title/Abstract] OR inactiv*[Title/Abstract] OR “substance abuse”[Title/Abstract] OR smok*[Title/Abstract] OR vaping[Title/Abstract] OR vape*[Title/Abstract] OR “e-cigarette*”[Title/Abstract] OR cigarette*[Title/Abstract] OR tobacco[Title/Abstract] OR drug*[Title/Abstract] OR alcohol*[Title/Abstract] OR “mental health”[Title/Abstract] OR “emotional health”[Title/Abstract] OR “psychological health”[Title/Abstract] OR wellbeing[Title/Abstract] OR “well-being”[Title/Abstract] OR diet*[Title/Abstract] OR “health* food*”[Title/Abstract] OR food*[Title/Abstract] OR nutrition*[Title/Abstract] OR “eating behav*”[Title/Abstract] OR sleep*[Title/Abstract])) AND (intervention*[Title/Abstract] OR change[Title/Abstract] OR program*[Title/Abstract] OR behav*[Title/Abstract] OR lifestyle[Title/Abstract] OR education*[Title/Abstract] OR “health promotion*”[Title/Abstract] OR effect*[Title/Abstract])) AND (youth[Title/Abstract] OR adolescen*[Title/Abstract] OR teen*[Title/Abstract] OR pupil*[Title/Abstract] OR student*[Title/Abstract] OR “young people*”[Title/Abstract])) AND (poverty[Title/Abstract] OR “low income”[Title/Abstract] OR “low-income”[Title/Abstract] OR “economic factor*”[Title/Abstract] OR “social inequali*”[Title/Abstract] OR socioeconomic*[Title/Abstract] OR “social economic*”[Title/Abstract] OR “social-economic*”[Title/Abstract] OR “social class”[Title/Abstract] OR “welfare assist*”[Title/Abstract] OR “social assist*”[Title/Abstract] OR subsidi*[Title/Abstract] OR “economic burden”[Title/Abstract] OR unemploy*[Title/Abstract] OR disenfranchi*[Title/Abstract]

OR impoverished[Title/Abstract] OR penniless[Title/Abstract] OR “financially disadvantaged”[Title/Abstract] OR “financially distressed”[Title/Abstract] OR “economically disadvantaged”[Title/Abstract] OR “socially disadvantaged”[Title/Abstract] OR “health literacy”[Title/Abstract] OR “health proficien*”[Title/Abstract] OR “health inequalit*”[Title/Abstract] OR “health equit*”[Title/Abstract] OR “health qualit*”[Title/Abstract] OR “health inequit*”[Title/Abstract] OR “health disparit*”[Title/Abstract])

Appendix C: Word Cloud Example

Appendix D: Co-design workshop Question Guide (Study 2)

Purpose:

To gather the perceptions, feedback, and suggested changes on the LifeLab learning activities from socioeconomically disadvantaged adolescents in order to refine the experience in preparation for rollout.

Objectives:

1. To identify if the students enjoyed their learning activities
2. To identify which aspects of the learning activities that the students enjoyed most
3. To identify if there were any aspects of the learning activities in which the students did not enjoy
4. To identify if the students found the learning activities interesting, fun, engaging, exciting and informative
5. To identify if the students would like to see any other health-related topics covered within LifeLab
6. To identify any changes the students would make to the learning activities to improve their experience

Icebreaker

1. How would you describe this station? – using the word cloud function on Vevox

Likert-style questions on Vevox

2. On a scale of 1-5, how interesting did you find the learning activity idea?
3. On a scale of 1-5, how fun did you find the learning activity idea?
4. On a scale of 1-5, how engaging did you find the learning activity idea?
5. On a scale of 1-5, how exciting did you find the learning activity idea?

Question Guide

6. What about the activity was/was not fun, exciting, interesting, engaging?
7. What do you think other people would enjoy (or other suitable word from above)?
8. What are the most important things to change to improve this activity?
9. Do you think the topics covered in the activity are important?
10. What other health topics would be important to cover in this LifeLab activity?

11. How much time would you spend on this activity?

12. Other than what has already been said, do you want to say anything else about the activity?

Appendix E: Plain Language Statements and Informed Consent/Assent

Plain Language Statement for Students and Parents

Principle Investigator: Dr. Sarahjane Belton

Researchers: Dr. Hannah Goss, Mr.Craig Smith, and Dr. Johann Issartel

Data Controller: Dublin City University

DCU Data Protection Officer: Mr. Martin Ward

DCU Data Protection Officer details: data.protection@dcu.ie
Ph: 7005118 / 7008257

You are being invited to take part in a research study funded by the Irish Heart Foundation to be carried in Dublin City University (DCU). Please read the information below carefully with your parent/guardian. You don't have to take part in this research. You should clearly understand the risks and benefits of taking part so that you can make a decision that is right for you. This process is known as 'Informed Consent'. If you have any questions, please contact the researcher. You can change your mind about taking part in the study any time you like. Even if the study has started, you can still change your mind. You don't have to give us a reason.

<u>If you are willing to take part in this research, please tick the appropriate boxes, complete the attached forms and return it to the school.</u>

Why is this study being done?

We are trying to improve adolescent's health knowledge and understanding and help young people to take more control of their health. The school setting is the ideal space to do this, so we are working with your school. We will work with students and teachers in your school to develop some new and more interactive ways to think and learn about health at school, and part of this may include a visit to a health lab at Dublin City University. Everything that is developed for your school, will be developed through lots of people working together – you, your teachers, and some of us researchers form DCU.

What will happen to me if I agree to take part?

By agreeing to participate in the project you will be able to:

1) Help design new health programmes for your school,

2) Give feedback on what you like and don't like about health and wellbeing classes at school

3) Fill in a questionnaire about different elements of your health, and

4) Visit an interactive health lab at DCU.

Your class group will all be taking part in the LifeLab intervention as part of your normal school timetable, but by agreeing to take part in this research you will also be able to tell us what you like and don't like about those classes and the visit to LifeLab. In LifeLab, you will have the chance to complete various hands-on activities where you will learn about different health topics.

To help us evaluate and improve both the school-based and lab-based experience, you will be asked to take part in simple conversations with other students in your school and the DCU researchers known as 'focus groups'. These conversations will always take place during school time, at different times during the school year, and your class teacher will be the one to arrange them with you. The discussions will be audio-recorded and used by the research team only to try and help make the health programmes better for students in the school. You will also fill in some health-related questionnaires to measure if the health program was effective, and to get feedback on what you thought of it.

What are the benefits?

You will have the opportunity to learn about health and wellbeing through interactive activities, both in a University lab and in the school setting. You will also have the opportunity to contribute to the development of a health programme that works well for your school.

What are the risks?

There are very minimal risks associated with this research. The risk associated with the LifeLab visit will be no greater than that involved in PE classes.

What will happen to my data?

We will be using your personal health information in our research to help us study health literacy and health in undergraduate students. Data from this study will be used by the research team and in future publications, but your name will never be used, and no one outside of the research team will ever be able to identify your data. We will comply with applicable regulations, including the processing of your data under legitimate interest and for scientific purposes (Article 6 and 9 of the General Data Protection Regulation (GDPR) 2016. All information gathered will be stored on the encrypted DCU server, only accessible by the research team, and will be disposed of after 5 years. Confidentiality cannot be promised for a couple of reasons; (i) as it involves focus groups; (ii) with regard to information disclosed that indicates a persons' safety or welfare is at risk from peers, staff, family or another source, we will follow the universities safeguarding policies and procedures.

Participants may withdraw from the Research Study at any point by contacting Dr Sarahjane Belton. This will have no negative consequences. Your participation in the project will end at the point you withdraw, and no future data collection will take place, previously collected data will still be processed, as described above, this information will not be identifiable. As an individual, you have the right to lodge a complaint with the Irish Data Protection Commission if you feel your data has been mishandled.

Where can I get further information?

If you want to opt out of the study, or if you need any further information now or at any time in the future, please contact:

Name: Dr. Hannah Goss Phone No: 017007441 Email: Hannah.Goss@dcu.ie

Name: Craig Smith Phone No: 017007441 Email: Craig.smith57@mail.dcu.ie

Name: Dr. Sarahjane Belton Phone No: 017007393 Email: Sarahjane.belton@dcu.ie

If participants have concerns about this study and wish to contact an independent person,

please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000, e-mail rec@dcu.ie

Informed Consent for Students and Parents/Guardians

Health Literacy Project

Consent form for Students and Parents/Guardians

This form is to be completed by participants and parent/guardian to give consent to take part in the research study with Dublin City University.

Please read the plain language statement attached. Involvement in the research study is voluntary, and you may withdraw at any point. No identifying information about any participants will ever be shared or published. The audio recording of the focus group discussion will be destroyed as soon as it is transcribed. We are committed to protecting people involved in our research. Confidentiality cannot be promised with regard to information disclosed that indicates a persons' safety or welfare is at risk from peers, staff, family or another source.

Participant assent and parent/guardian consent to take part in the research study – please tick where agreed:

- ☐ I have read the Plain Language Statement (or had it read to me)
- ☐ I understand the information provided
- ☐ I have had an opportunity to ask questions and discuss this study
- ☐ I have received satisfactory answers to all my questions
- ☐ I am aware that I will be taking part in newly designed school-based learning activities
- ☐ I am aware that I will be completing surveys and questionnaires
- ☐ I am aware that I will be taking part in LifeLab, a interactive hands-on experience
- ☐ I am aware that I will be part of audio-recorded focus groups in this study

Signatures:

I have read and understood the information in this form. My questions and concerns have been answered by the researchers. Therefore, I consent to take part in this research project

Student Signature: ____________________________________

Name in Block Capitals: ________________________________

Parent/Guardian Signature: ____________________________

Name in Block Capitals: ________________________________

Date: ____

Plain language statement for teachers

Health Literacy Project

Plain Language Statement for Teachers

Principle Investigator: Dr. Sarahjane Belton

Researchers: Dr. Hannah Goss & Mr. Craig Smith

Data Controller: Dublin City University

DCU Data Protection Officer: Mr. Martin Ward

DCU Data Protection Officer details: data.protection@dcu.ie
Ph: 7005118 / 7008257

You are being invited to take part in a research study funded by the Irish Heart Foundation to be carried in Dublin City University (DCU). Please read the information provided below carefully. You don't have to take part in this research. You should clearly understand the risks and benefits of taking part so that you can make a decision that is right for you. This process is known as 'Informed Consent'. If you have any questions, please contact the researcher. You can change your mind about taking part in the study any time you like. Even if the study has started, you can still opt out. You don't have to give us a reason.

If you are willing to take part in this research, please tick the appropriate boxes, complete the attached forms and return it to the school.

Why is this study being done?

We aim to co-design a health literacy intervention with the students and teachers of DEIS schools. The intervention will consist of school-based learning linked with formal school curriculum (delivered by schoolteachers) and an out of school experience in an interactive lab (LifeLab), based at DCU. Through the design of this intervention, we aim to develop a sustainable tool which can be integrated into the Junior Cycle Wellbeing Curriculum to improve adolescent's health knowledge and understanding, and ultimately provide them with the ability to take control of their health. This intervention provides the opportunity for students to learn about the importance of a healthy lifestyle in reducing immediate and future health risks. The co-design process will ensure that the intervention meets the needs of the school community. This phase of the study will evaluate the implementation of the intervention to obtain feedback from the school community and LifeLab facilitators.

What will happen to me if I agree to take part?

If you agree to take part in the study:

You will be involved in the design of a health literacy intervention, and may take part by implementing the school-based elements of the intervention. All school-based elements of the intervention will be co-designed with the students and staff of the participating DEIS schools, and agreed by school management before roll out.

You will be asked to meet periodically with the DCU researchers to discuss the acceptability and feasibility of the intervention components as they are trialled in your school. Focus groups and/or interviews will be held to facilitate these discussions. The discussions will be audio-recorded and used by the research team only. Routine observations of the school-based element will be conducted by the researcher to evaluate the delivery and fidelity of the intervention. In addition, you may be asked to take notes periodically of elements of the intervention that are being implemented, and how well you feel they are working.

You may be asked to attend a class trip to the interactive health lab at DCU. The duties of the teacher during the student's lab experience will be limited to observation and supervision, while the DCU researcher facilitates the session. On completion of the lab session, the teacher will be asked to provide feedback on the session through an interview administered questionnaire over the phone or, if preferred, via a survey software.

You will also be asked to complete questionnaires regarding your own health literacy and wellbeing levels, and the health literacy responsiveness levels of the school community.

What are the benefits?

You will contribute to the development of a health literacy intervention, a new Wellbeing curriculum and potentially a healthier school. All intervention materials developed will be freely available to you to use in your school for as long as you like.

What are the risks?

There are no risks for participating teachers. Any risks for student participants have been detailed in the student plain language statement.

What will happen to my data?

We will be using your personal health information in our research to help us study health literacy and health in undergraduate students. Data from this study will be used by the research team and in future publications, but your name will never be used, and no one outside of the research team will ever be able to identify your data. We will comply with applicable regulations, including the processing of your data under legitimate interest and for scientific purposes (Article 6 and 9 of the General Data Protection Regulation (GDPR) 2016. All information gathered will be stored on the encrypted DCU server, only accessible by the research team, and will be disposed of after 5 years. Confidentiality cannot be promised for a couple of reasons; (i) as it involves focus groups; (ii) with regard to information disclosed that indicates a persons' safety or welfare is at risk from peers, staff, family or another source, we will follow the universities safeguarding policies and procedures.

Participants may withdraw from the Research Study at any point by contacting Dr Sarahjane Belton. This will have no negative consequences. Your participation in the project will end at the point you withdraw, and no future data collection will take place, previously collected data will still be processed, as described above, this information will not be identifiable. As an individual, you have the right to lodge a complaint with the Irish Data Protection Commission if you feel your data has been mishandled.

Where can I get further information?

If you want to opt out of the study, or if you need any further information now or at any time in the future, please contact:

Name: Dr. Hannah Goss Phone No: 017007441 Email: Hannah.Goss@dcu.ie

Name: Craig Smith Phone No: 017007441 Email: Craig.smith57@mail.dcu.ie

Name: Dr. Sarahjane Belton Phone No: 017007393 Email: Sarahjane.belton@dcu.ie

If participants have concerns about this study and wish to contact an independent person,

please contact:

The Secretary, Dublin City University Research Ethics Committee, c/o Research and Innovation Support, Dublin City University, Dublin 9. Tel 01-7008000, e-mail rec@dcu.ie

Informed Consent for Teachers

Health Literacy Project

Consent form for Teachers

This form is to be completed by teachers to give consent to take part in the research study with Dublin City University.

Please read the plain language statement attached. Involvement in the research study is voluntary, and you may withdraw at any point. No identifying information about any participants will ever be shared or published. The audio recording of the focus group discussion will be destroyed as soon as it is transcribed. We are committed to protecting people involved in our research. Confidentiality cannot be promised with regard to information disclosed that indicates a persons' safety or welfare is at risk from peers, staff, family or another source.

Teacher consent to take part in the research study – please tick where agreed:

☐ I have read the Plain Language Statement

☐ I understand the information provided

☐ I have had an opportunity to ask questions and discuss this study

☐ I have received satisfactory answers to all my questions

☐ I am aware that I will be implementing a newly designed school-based learning activities

☐ I am aware that I may be accompanying my class group to an interactive lab in DCU

☐ I am aware that I will be involved in the iterative evaluation and refinement process of the intervention

☐ I am aware that I will be part of audio-recorded interviews in this study

☐ I am aware that I will be assessing my health literacy and wellbeing levels and the health literacy responsiveness levels of the school community

Signatures:

I have read and understood the information in this form. My questions and concerns have been answered by the researchers. Therefore, I consent to take part in this research project

Signature: ____________________________________

Name in Block Capitals: ________________________________

Date: ____

Appendix F: Post-LifeLab Student Focus Group Question Guide (Study 3)

Purpose:
To evaluate the student's experience of LifeLab and to receive feedback from the students to guide the refinement of the lab for the intervention rollout.

Objectives:

1. To identify elements of the LifeLab experience that the students enjoyed
2. To identify elements of the LifeLab experience that the students did not enjoy
3. To identify if the students found the experience educational
4. To identify any changes the students would make to LifeLab to improve their experience

Questions:

1. What was your favourite part about your visit to LifeLab?

Probes:

- Why was it your favourite?
- Were there any activities that you really liked? What made these so enjoyable?
- Was there anything else about LifeLab that you particularly enjoyed?
- Did you feel you had enough time on each station?

2. What was your least favourite part of your visit to LifeLab?

Probes:

- Why was this your least favourite?
- How could this be better?
- Did you feel you had enough time on each activity?
- Did you feel like you knew what to do in each activity?

3. Did you learn anything new today about health?

Probes:

- Which activity did you find most interesting?
- Go through each station individually (what station did you do first?)…
- Do you feel LifeLab will help you and your classmates' understand health a little more?
- Do you think that there is anything else you would like to learn about in LifeLab?

4. Thank you for today. Is there anything else you'd like to tell me about LifeLab that you haven't had the chance to say already?

Appendix G: Post-LifeLab Teacher Focus Group Question Guide (Study 3)

Purpose: To evaluate the teacher's perceptions of the overall LifeLab intervention and to guide the iterative development of the intervention

Objectives:

1. To explore the teacher's perceptions of the LifeLab intervention, including the identification of strengths and weaknesses
2. To explore the feasibility of the LifeLab intervention from the teacher's perspective
3. To identify barriers and facilitators to implementation
4. To identify changes that the teachers would make to improve the LifeLab intervention

Questions:

1. From your perspective, how do you feel the LifeLab intervention went?
   - What went well?
   - What didn't go so well?
   - In particular, what went well/didn't go well during the school-based element?
   - In particular, what went well/didn't go well during the LifeLab visits?

2. How do you feel the students responded to the LifeLab intervention?
   - Do you feel the students benefitted from the intervention? If so, in what way?

   Focusing on the school-based element / LifeLab visit separately:
   - Were there any elements of the intervention that you felt the students particularly benefitted from?
   - Were there elements that were particularly engaging / enjoyable for the students? If so, why so?
   - Were there elements that were particularly educational / relevant to the students? If so, why so?
   - How might we improve the intervention to enhance these things?

The feasibility of the intervention:

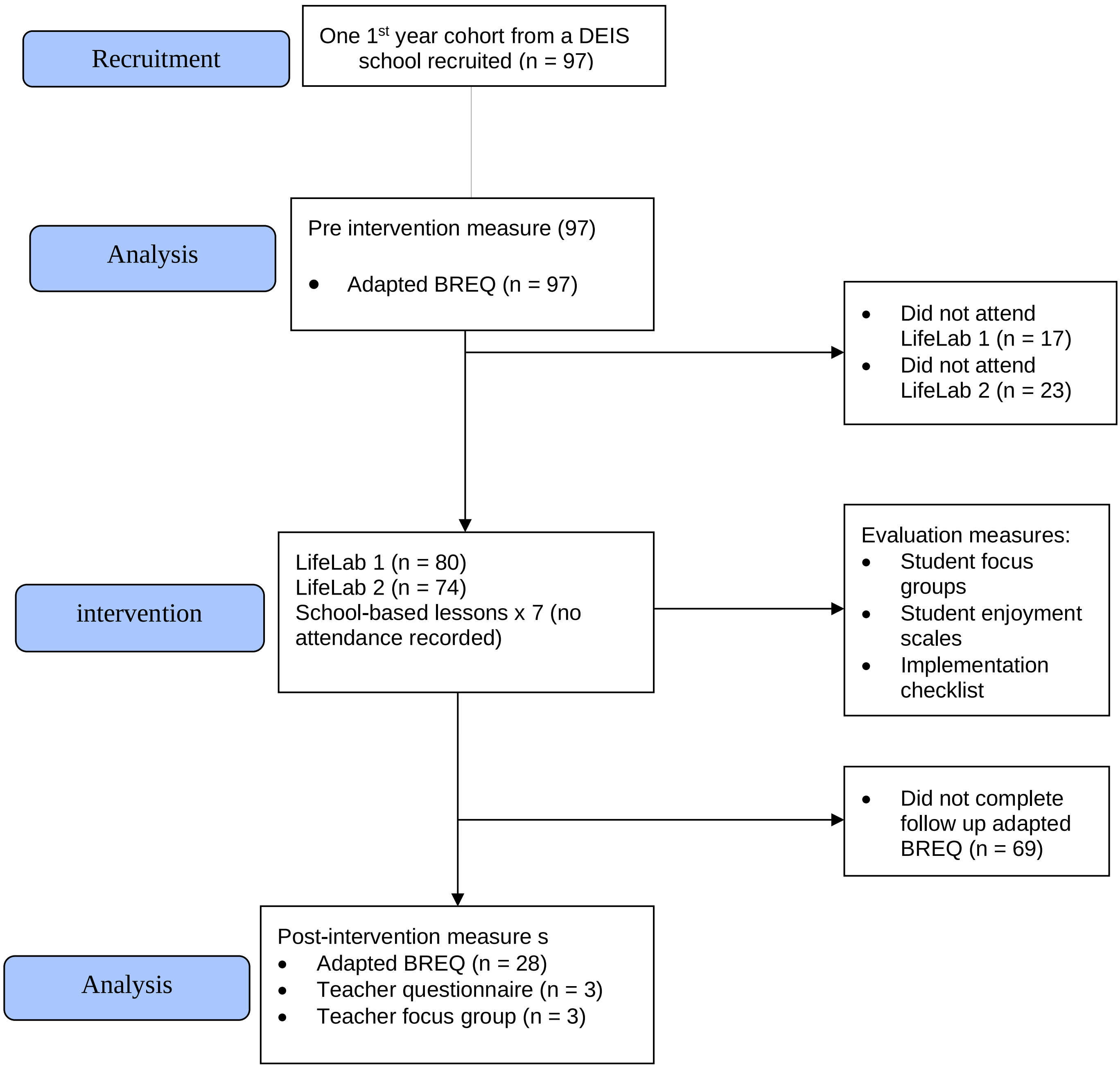
3. (i) LifeLab visits:
   - What did you think of the amount of time spent in LifeLab?
   - What did you think of the number of visits to LifeLab?
   - What did you think of the resources we had in LifeLab?
   - How did the visits fit into the SPHE curriculum?
   - How did it fit into the SPHE timetable?

3. (ii) Implementing the school-based lessons:
   - What did you think of the lesson's structure?
   - What did you think of the lesson's content? (refer to previous conversations)
   - Were there any elements that you felt worked particularly well?
   - Were there any elements that you found difficult to implement?
   - What did you think of the resources that were provided for the lessons?
   - Are there any resources that you can think of that would help to implement the intervention?
   - What did you think about the length of the intervention?
   - How did the school-based element fit within the current SPHE programme in the school?

3. Looking at the LifeLab intervention as a whole (LifeLab visits and school-based elements):
   - Would you recommend the LifeLab intervention to other SPHE teachers? Why or why not?
   - What challenges did you face?
   - What advice would you give to a SPHE teacher who was going to implement the LifeLab intervention?

So, we've covered quite a lot here. You've given some really good feedback on what's going on in your school. Can I just check if there's any last things you don't think we've covered that you'd like to add? ….Thank you for giving up your time.

Appendix H: Consort Diagram of LifeLab Intervention



Appendix I: LifeLab Core Principles

Principle	What it looks like in practice
Participative	Students are given the opportunity to input, engage
Holistic	All previous health topics identified by this cohort are serviced during the LifeLab visits
Equitable	All students should have access to LifeLab and differentiation is provided if needed
Health literacy focussed	All health literacy capabilities serviced during LifeLab (functional, interactive, and critical)
Empowerment	Students are given the opportunity develop competencies and knowledge to take control of their health
Strengths based	Each learning activity considers the students' strengths and assets
DEIS focussed	Learning is tailored to the context and ability of the DEIS students The students are asked 'is this relatable? do you understand this?' at every activity
Experiential experience	Students are given the opportunity to experience interactive learning tasks
Constructivist pedagogy focus	Students are given the opportunity construct or develop their own knowledge through their experiences in the LifeLab activity
Autonomy (SDT)	Students are given the opportunity to explore the learning within the learning activity for themselves (or as a group)
Relatedness (SDT)	The students can relate to the learning and their peers during the experience

Competence (SDT)	The students acquire confidence through completing the task at hand and developing learning around the topic area

Appendix J: Protocols for LifeLab learning activities

LifeLab 1 - Sleep

Health Literacy Skills: • Knowledge and understanding • Critical appraisal • Application of a health behaviour
Aims and Learning Intentions: • To understand the factors that impact sleep • To understand the importance of sleep hygiene • To find methods to make different choices around sleeping habits
The Experience: • Students will be broken down into 'Scientists' and 'participants' • The participants will each have a zone (tent) partition. The participants will be exposed to a stimulus that we know impacts our ability to fall asleep or impacts the quality of sleep (bright light, gaming, phones, noise, stressful situation, a warm temperature) • The participants will be "hooked up" to a device that will be measuring their "live" brain activity, temperature, alertness, stress levels or whatever the relevant measure is that corresponds to the stimulus. The output from these will be shown to the scientists on a screen at the other side of the partition. (This output will be faked) • The scientists then need to investigate which stimulus their participants were exposed to • Once they have identified the factor that was influencing sleep, they must come up with ideas on how to improve sleep hygiene (relaxing music/meditation instead of gaming/stress, blue light glasses if on phone/TV, reading instead of gaming/social media scrolling/TV, cooling down the room etc.). • Vignette data can be shown at the station (e.g. Dylan's brain wave data after a night of gaming or Emma's alertness after spending hours on her phone before bed - these will be further heightened compared to the data shown from the 'participants' as they will only have been exposed to it for a short period of time)

LifeLab 1 – Mental Health

Health Literacy Skills: • Knowledge and understanding • Application of a health behaviour
Aims and Learning Intentions: • To identify factors in adolescents lives that affect mental health and wellbeing • To identify tools to overcome or manage such factors
The Experience: • In groups, participants will come up with as many tools/life skills as they can that they feel are important for self-managing. Some key examples of these will be provided to help guide the participants • Similarly, they will come up with barriers (examples provide to guide) – these will be placed on the physical structures on the inside of the octagon • The group will be presented with the octagon shaped board – the participants will have to write a life skill/tool on each side of the board (these will be based on the first task that they carry out) and the barriers on the inside structures • They will also be presented with two vignettes • The first thing the participants will need to do is identify a factor in the vignette's life that may be affecting their wellbeing. Once they have done so, they then need to come with 2/3 possible tools/life skills that may help the vignette manage this situation – they can use a life skill that they have placed around the side of the board or come up with another • After identifying the source of stress and two possible life skills/tools, the team must pick up the board-like object and place a ball on it. On the ball, they will write down the tool/life skill. They will then need to manoeuvre the board in a way that allows the ball to hit the vignette and then the tool/life skill they have identified • Once they have hit the ball against both, they must roll the ball directly into a toolbox to one side of the board • If they hit anything along the way they must start again. They will be competing against the clock to get as many solutions as possible – timer will depend on how long the first task takes, but they like it to be competitive, so let's make sure we add some sort of time constraint • The goal at the end of the session is for the students to have developed multiple ideas on how to manage stressful situations. These will be placed in a physical toolbox for the students to bring with them leaving LifeLab

LifeLab 1: Social and Environmental Factors that Influence Health

Health Literacy Skills: • Critical Appraisal • Knowledge and understanding
Aims and Learning Intentions: • Critically assess health information shown online, in advertisements, on social media and on food packaging (in our social and physical environment) • Understand how misinformation/fake news can influence our behaviours
The Experience: • Students will be broken down into teams (dependent on numbers) and be presented with a who wants to be a millionaire style game on a ppt. • They will be faced with various questions/scenarios/true or false statements that relate to health information that they may be exposed to in their daily life. For example, these may include: ○ Social media influencers – selling the products that are either harmful or unethical ○ Website articles ○ Fad diets – online or promoted on social media ○ Food packaging – misleading information (‘low fat’ or ‘good source of X’) ○ Advertisements (TV or otherwise) ○ Netflix documentaries/YouTube clips Discussions are formed around the most contentious posts. Why are they contentious? What are the major issues with such misleading information? How do you know if something is real or fake? Who/What can you believe? Social media algorithms targeting our biases? - a debate-style session as recommended in the co-design workshops?

LifeLab 1: Physical Activity

Health Literacy Skills: • Knowledge and understanding • Application
Aims and Learning Intentions: • To understand the barriers to PA • To understand how PA contributes to positive health and wellbeing • To identify methods to improve PA of young people

The Experience:
• The students must navigate their way through a game of snakes and ladders, using the allocated figurine
• In the game of S&Ls each box will have PA related tasks, such as:
    o Questions on PA - wrong answers will mean moving backwards in the game. These could include socio-environmental issues/questions, questions around the benefits of exercise, implications of exercise, types of exercise, exercise guidelines, screen time
    o An issue the vignette has faced that student must solve before moving on (barriers to PA and methods to overcome them) - role play
    o PA tasks (Xbox exergame, simple PA movements, reaction tests, hang bar)
• To ensure that the students have a choice, they will have the option of what PA task they want to complete (try ensure that they try them all) or they can answer a question or face a scenario instead
• First one to the end wins, the students have asked for a little competition – so once there is a winner, they can start again

LifeLab 1: Food Choices

Health Literacy Skills: ● Knowledge & Understanding ● Application
Aims and Learning Intentions: • Understand what are balanced food habits • Explore the importance of balanced food choice for health and wellbeing (in terms of energy levels, nutrient density, variety of foods, role of macronutrients) • Explain that different lifestyles require different dietary requirements • Explore values, motivations and influences on food choices and how we should try to make the best choice as often as possible • Understand the role of substitute food items to make meals more nutritious • Design healthy recipes that can be brought home and trialled
The experience: • Each group is assigned a vignette (there will be a male and female vignette that the group can choose from) – which comes with a one day food diary (the diary will include typical foods that adolescents will commonly - chicken fillet rolls/Dominos/McDonalds/local food outlets along with healthy food items). • The team needs to consider how food fits into the vignette's life (consider elements like: energy levels, enjoyment in eating the foods, healthiness, satiety, cost, accessibility, availability, preparation/cooking skills etc.) – this will be through a smiley face scale • Then they must modify the vignette's food choices to make them healthier, where possible. • The studenst discuss the modification made by each group – this discussion is led by the facilitator with an intention of ensuring that the choices are realistic and achievable • After adjusting the food diary, the students need to find a recipe, using the tablet, that they would like to try or would recommend other people try

LifeLab 2 - Physical Activity

Health Literacy Skills: • Critical appraisal • Knowledge and understanding
Aims and Learning Intentions: • Understand the health impacts of physical activity and inactivity • Develop critical appraisal skills in relation to PA information
The Experience: • Using the ppt provided, the facilitator will give a quick overview of how the station will operate • The students will be presented with multiple modes of physical activity such as cycling, hula hooping, punching bag, basketball hoop, arm ergometer, head/throw game etc. • The students will be broken into 2 teams (Team A v Team B) • The first thing the students will do is "power up" a video by completing a short bout of PA – they can choose whichever mode they would like and all students (from both teams) complete this together • This PA will be light • A graphic will be shown on screen of the video being "powered up" • Once complete, the students will watch the short video together and then in their teams they will answer a series of questions on the video. These will be True or False questions or statements that the students must agree, strongly agree, disagree or strongly disagree with. • The students will be given 15 seconds to discuss each Q with their group and will then need to make a decision • The videos will be based around the benefits of PA • The team will be allocated a point if they choose the correct answer in the True or False Q's and will be provided a point if they can justify why they agreed/disagreed with a statement • The team with the most points at the end of the station wins the game • Discussions after each question are really important to – you can set this up as a debate style. Try to link these discussions back to real life, in particular how students can apply the learning to their actual life • Most of the discussion will be around the agree/disagree style and list-style questions, as these are more contentious. But feel free to discuss other questions as well. • Prompts will be provided for these questions in the comments section of the ppt. • Note that there won't always be right or wrong answers to the questions/statements, it's all about the students justification and the learning around certain actions • *One foot on boxing bag to keep it from moving and for a better stance*

LifeLab 2 - Food Choices

Health Literacy Skills: • Critical Appraisal • Knowledge and understanding
Aims and Learning Intentions: • Understand the health impacts of food choices • Develop critical appraisal skills in relation to nutrition information commonly exposed to young people
The Experience: • The students will complete tasks where they are identifying red flags – one on a label of an energy drink, another on a social media post and one on a junk food advert • 'Red flags' are explained as things that people should be aware of when they see such posts / advertisements • The students will be broken down into two teams to ensure that there is a competitive element • Students complete each elements at the same time and attempt to identify as many red flags as possible • For each appropriate red flag identified, the team will gain a point • Discussions around each red flag is critical – get the students to elaborate on why they chose each red flag and how it relates to the health of adolescents in their community • In particular, how exposure to such claims / information can impact young people's health – implications of poor choices around caffeine, sugar, and other harmful ingredients, weight loss supplements etc. • Incorporate discussions between the two teams • At the end, students can write down suggestions they have for other social media accounts that they like or that could be added to the station

LifeLab 2 – Sleep

Health Literacy Skills:

- Knowledge and understanding

Aims and Learning Intentions:

- Understand the importance of sleep for performing daily tasks
- Understand how scores in physical and cognitive tests are related to everyday tasks
- Understand how sleep deprivation can impact on quality of life and short/long term health

The Experience:

- The experience will start by giving the students one minute to come up with as many ways as possible that sleep impacts health and daily activities - make it competitive by attempting to beat the score of the group in front. The students will write these down
- Then the facilitator will give the students a quick overview of how the station is going to operate
- The students will be introduced to the battery of tests (memory tests, reaction tests, cognitive tests, strength tests). The tests will be spread over three desks, with each des testing something specific
- The students have the opportunity to complete these tests (give them 3 minutes per test)
- As they are completing them, get them to think about how they might relate to real life
- Afterwards, they will need to write down what each test relates to - see if they link to what they identified in the starter activity
- Again, score how many they get and compare it to other groups (use the template on the whiteboard to complete)

LifeLab 2 – Mental Health

Health Literacy Skills: • Application • Knowledge and understanding
Aims and Learning Intentions: ● To understand how life situations impact mental health and wellbeing ● To identify techniques that help alleviate stress caused by life situations
The Experience: ● This station should not be called the mental health station – we need to ensure that the stressful situation is believable ● The students can wear a HR monitor (if they want) to measure possible physiological changes in acute stress levels during the station experience. It should be highlighted to the students that these HR monitors are for the next station, as to not give away what is happening ● The students will then face a stressful situation (an exam) ● The students will each sit at a computer (this station will be located in the comp room), with a sign on the door saying 'exam in progress' ● At each computer, there will be an exam laid out, which the students will be asked to complete ● To enforce the reality of the exam situation, all typical measures will be in place – quietness, no talking, spiel about how the exam is worth a % in their science Christmas exam etc. ● After a 1 – 2 minutes, the students will be informed that it is not in fact an exam and the facilitator will hold a brief discussion around stress levels as a result of the exam - look at your HR, is it elevated? How did you feel when we told you it was an exam etc. ● Next, the students will complete a very brief 2 minute relaxation technique - using the computers in front of them, which will have the video set up. ● Next, the students, using the equipment provided, will be able to try other ways that they feel would help with managing stress in a situation like this (relaxing music, books, colouring books, comfy space, meditation, mindfulness etc.) ● After 3/4 minutes of relaxing, the students are brought out of the zones and are shown a graph of their groups average HR changes (faked data)– signalling their change in stress levels over the course of the station ● A brief discussion will be held around what else might cause them stress and what teenagers could do to relax (informative for designing the station going forward but also educational for all involved) - the students to fill out sticky notes highlighting these ● The students are asked to ensure that they do not tell the next students about this station as we do not want to ruin the learning for them. By getting them involved in creating stressful situations, we can involve them in the secret which may help with this. They will also need to sign the confidentiality form

LifeLab 2: Substance Misuse

Health Literacy Skills:

- Knowledge and understanding

Aims and Learning Intentions:

- Understand the impact of substance misuse on short and long term health
- Understand how certain substances affect the body

The Experience:

- The students will be broken down into two teams
- The students will play a pairs match game, whereby they will need to match up cards detailing certain substances with their potential effects / related information - these will be colour coded
- Make sure to give an example of this
- After getting three matches, they will have the chance to earn a point for their team by choosing a ‘diseased’ body image (on a card at the station), placing it on the whiteboard and briefly writing down what is happening (based on the cards that they have matched)
- At the end of the station, the team with the most body part images and explanations ‘wins’
- Extension - discussion around the vignette shown on the wall. Why they may be tempted to try out such behaviours, how best to avoid etc.
- Discussions around substance misuse is the key to this activity – the pairs match game is merely a method to engage the students

Appendix K: Learning Activities and Co-designed Elements

LifeLab 1.

Co-designed element	**Physical Activity**	**Food Choices**	**Mental Health**	**Sleep**	**Social and Environmental Factors**
Healthy competition	✓	✓	✓		✓
Interactive tasks	✓		✓	✓	✓
Problem solving	✓	✓	✓	✓	✓
Variety and choice	✓		✓	✓	✓
Relating learnings to real life	✓	✓	✓	✓	✓
Influence of social media		✓	✓		✓
Lifestyle behaviours and health	✓	✓	✓	✓	✓

LifeLab 2

Co-designed element	**Physical Activity**	**Food Choices**	**Mental Health**	**Sleep**	**Substance Misuse**
Healthy competition	✓	✓		✓	✓
Interactive tasks	✓	✓	✓	✓	✓
Problem solving	✓	✓	✓	✓	✓
Variety and choice	✓	✓	✓	✓	
Relating learnings to real life	✓	✓	✓	✓	✓
Influence of social media	✓	✓			
Lifestyle behaviours and health	✓	✓	✓	✓	✓

Appendix L: Pedagogy Pointers for LifeLab learning activities.

LifeLab 1: Social and Environmental Factors & Health
Core Pedagogy Pointers!

Delicate balance between being 'game show host' and teacher when dealing with incorrect answers

Do!	Don't!
Be overly enthusiastic – need it to be contagious!	Expect the students to be enthusiastic/motivated right away – you may need to lead them there
Deal sensitively with incorrect answers e.g. 'I can see why you thought that would be the answer, but unfortunately it is incorrect!'	Say 'No you are wrong!'
Give BRIEF explanation around the answer in question, particularly where the students haven't gotten it correct (use questioning also) – but don't take too long!	Skip on too quickly to the next question without taking the opportunity to develop learning
Use competition to the extent that it is healthy	Let competition create a negative experience for anyone
Demonstrate high level of enthusiasm, use voice and body language to convey that all are welcome, and everyone's voice is important	Skip past quiet students, or let anyone feel like they have 'failed'

LifeLab 1: Physical Activity
Core Pedagogy Pointers!

Do!	Don't!
Be overly enthusiastic – need it to be contagious!	Expect the students to be enthusiastic/motivated right away – you may need to lead them there
Use prompts and probes to help students reach correct answer	Just give the student the answer if they don't get it first time
Praise correct answers, good effort, and good performances	Sit back/be indifferent to students efforts and performances
Deal with incorrect answers carefully and tactfully, praise the effort, be positive, and use prompts and probes to help them reach the answer	Shoot the students down ('No, that's wrong'), or just give them the answers

LifeLab 1: Mental Health
Core Pedagogy Pointers!

Do!	Don't!
Spread the questions out, call on individuals rather than asking too many questions of the whole group – so all get opportunity	• Let one person answer all of the questions. • Force someone to answer if they are clearly uncomfortable.
Make sure all students are given the opportunity to meaningfully contribute and participate	Let one student dominate the group, and do most of the talking, with others sitting back quietly
Deal positively with unexpected responses e.g. 'that's a good suggestion, I can see why you would think that, however what if…'	Shoot the students down ('No, that's wrong'), or just give them the answers
Use prompts and probes to help students reach correct answer	Just give the student the answer if they don't get it right first time

LifeLab 1: Sleep
Core Pedagogy Pointers!

Do!	Don't!
Use questions to help students identify the meaning of the data they are seeing	Do all the talking, and give all the answers
Make sure that the 'participants' learn as much as the 'researchers' do	Let the first group of researchers take all of the time – even though they will have lots of questions!
Spread the questions out, call on individuals rather than asking too many questions of the whole group – so all get opportunity	• Let one person answer all of the questions. • Force someone to answer if they are clearly uncomfortable.
Make sure all students are given the opportunity to meaningfully contribute and participate	Let one student dominate the group, and do most of the talking, with others sitting back quietly
Deal positively with unexpected responses e.g. 'that's a good suggestion, I can see why you would think that, however what if…'	Shoot the students down ('No, that's wrong'), or just give them the answers
Use prompts and probes to help students reach correct answer	Just give the student the answer if they don't get it right first time

LifeLab 1: Food Choices
Core Pedagogy Pointers!

Do!	Don't!
Have some post-its on the table, but just what you need	Leave all post-its on the table – creates a serious distraction!
Make sure all students are given the opportunity to meaningfully contribute and participate	Let one student dominate the group, and do most of the talking, with others sitting back quietly
Deal positively with unexpected responses e.g. 'that's a good suggestion, I can see why you would think that, however what if…'	Shoot the students down ('No, that's wrong'), or just give them the answers
Use prompts and probes to help students reach correct answer	Just give the student the answer if they don't get it right first time

LifeLab 2: Substance Misuse
Core Pedagogy Pointers!

Do!	Don't!
Provide a clear explanation of the station at the start – use a demo	Overly complicate the station, you may be able to explain some elements as they move through the station
Deal sensitively with incorrect answers e.g. 'I can see why you thought that would be the answer, but unfortunately it is incorrect!'	Say 'No you are wrong!'
Give BRIEF explanation around the answer in question, particularly where the students haven't gotten it correct (use questioning also) – but don't take too long!	Skip on too quickly to the next question without taking the opportunity to develop learning
Use competition to the extent that it is healthy	Let competition create a negative experience for anyone
Demonstrate high level of enthusiasm, use voice and body language to convey that all are welcome, and everyone's voice is important	Skip past quiet students, or let anyone feel like they have 'failed'

LifeLab 2: Physical Activity
Core Pedagogy Pointers!

Do!	Don't!
Be overly enthusiastic – need it to be contagious!	Expect the students to be enthusiastic/motivated right away – you may need to lead them there
Provide clear, but brief demonstrations for each PA station	Go straight into the quiz game and allow the students to figure how to carry out the PA themselves
Prompt the students to try out different forms of PA and not just the same mode or a mode that they may have tried before	Let it be a free for all when it comes to the PA element
Use prompts and probes to help students reach correct answer	Just give the student the answer if they don't get it first time
Praise correct answers, good effort, and good performances	Sit back/be indifferent to students efforts and performances
Deal with incorrect answers carefully and tactfully, praise the effort, be positive, and use prompts and probes to help them reach the answer	Shoot the students down ('No, that's wrong'), or just give them the answers
Spread the questions out, call on individuals rather than asking too many questions of the whole group – so all get opportunity. Guide them to use team work	• Let one person answer all of the questions. • Force someone to answer if they are clearly uncomfortable.
Make sure all students are given the opportunity to meaningfully contribute and participate	Let one student dominate the group, and do most of the talking, with others sitting back quietly
Relate the learning back to real life application in the life of a teenager	Focus solely on the right and wrong answers and ignore the aims of the station

LifeLab 2: Sleep
Core Pedagogy Pointers!

Do!	Don't!
Spread the questions out, call on individuals rather than asking too many questions of the whole group – so all get opportunity	• Let one person answer all of the questions. • Force someone to answer if they are clearly uncomfortable.
Provide clear but brief demonstrations for all of the tests	Have the students figure out how to run the test themselves
Make sure all students are given the opportunity to meaningfully contribute and participate	Let one student dominate the group, and do most of the talking, with others sitting back quietly
Deal positively with unexpected responses e.g. 'that's a good suggestion, I can see why you would think that, however what if…'	Shoot the students down ('No, that's wrong'), or just give them the answers
Use prompts and probes to help students reach correct answer	Just give the student the answer if they don't get it right first time
Relate the learning back to real life application in the life of a teenager – how are these tests relevant, how do they relate to daily tasks	Focus solely on the test at hand , instead, link back to sleep and real life application

LifeLab 2: Mental Health
Core Pedagogy Pointers!

Do!	Don't!
Gauge how long you need to keep the exam going for – keep an eye on stress levels and end it early if needs be	Leave it go for too long and run the risk of causing too much stress
Allow the students to discuss how they felt during the exam	Move on straight away after the exam is finished
Use questions to help students identify how they felt	Do all the talking, and give all the answers
Relate the learning back to real life application (how a teenager may react in such a situation or how a teenager may use one of the relaxation technique	Focus solely on the situation at hand in the station – this is just an example
Guide the students to try out different relaxation techniques	Don't just let them chat amongst themselves
Spread the questions out, call on individuals rather than asking too many questions of the whole group – so all get opportunity	• Let one person answer all of the questions. • Force someone to answer if they are clearly uncomfortable.
Make sure all students are given the opportunity to meaningfully contribute and participate	Let one student dominate the group, and do most of the talking, with others sitting back quietly
Deal positively with unexpected responses e.g. 'that's a good suggestion, I can see why you would think that, however what if…'	Shoot the students down ('No, that's wrong'), or just give them the answers
Use prompts and probes to help students reach correct answer	Just give the student the answer if they don't get it right first time

LifeLab 2: Food Choices
Core Pedagogy Pointers!

Do!	Don't!
Explain clearly what we mean by red flags – make sure all students are aware of this	Go straight into the identification of red flags before explaining
Take your time and focus on the discussion around the identified red flags	Rush through the elements to ensure that the students complete all parts
Relate the learning back to real life application in the life of a teenager (how these posts / marketing etc. can impact a teenager's health)	Focus solely identifying as many red flags as possible - ensure that there is understanding
Make sure all students are given the opportunity to meaningfully contribute and participate	Let one student dominate the group, and do most of the talking, with others sitting back quietly
Deal positively with unexpected responses e.g. 'that's a good suggestion, I can see why you would think that, however what if…'	Shoot the students down ('No, that's wrong'), or just give them the answers
Use prompts and probes to help students reach correct answer	Just give the student the answer if they don't get it right first time

Appendix M: Example Lesson Plans and Material for School-Based Element

Lesson 1 Plan:

Learning Intentions: We Are Learning To...

- Develop a deep understanding of the terms health, health literacy, health behaviours and become aware of factors that influence health choices
- Become familiar with the key health topics that we will be focusing on: food choices, mental health & wellbeing, physical activity & sedentary behaviours , influence of social and environmental factors, sleep, substance misuse
- Begin to understand the ways in which each topic can influence our health

Success Criteria: What I'm Looking For…

- Students are able to define and understand the terms health, health literacy, health behaviours
- Students are capable of listing some factors that influence health choices
- Students understand the importance of learning and improving their health literacy, they convey this by setting goals for themselves
- Students can identify with the help of a visual stimulus the 6 key health topics
- Through interactive team games students start to explore the impacts that each topic has on their overall health

Introduction **Time: 7**

Description of Learning Activity / Teacher Activity

-Teacher takes the role and introduces the class to the new topic of 'Health Literacy'. The word 'Health Literacy' is presented on the board with symbols around it giving clues to what it might mean.
-Think, Pair, Share: Each student is asked to write down what they think the terms 'Health' and 'Health Literacy' mean in their own words without any help from other sources. Students discuss their answers with their partner, comparing and contrasting. Finally, the teacher asks each pair to read out what they wrote. The class discusses each answer, the teacher guides the discussion closer to forming the real definition of each term. 'Together' the class discovers the definitions for each term that will be used over the course of the program. **5 mins**
-Each student is then instructed to 'write down 5 things that make a healthy person' (e.g eats healthy food, exercises etc). This can be done on mentimeter. After everyone submits their own ideas they look up to the big screen to see what everyone has written. **2 mins**
-Each student is put into a team, this is going to be their team for the entire HL program. They must come up with a team name, team symbol and team quote before next week's class. The teacher should have the teams (of no more than 5) chosen before the class. **2 mins**

Progression of Lesson **Time: 28**

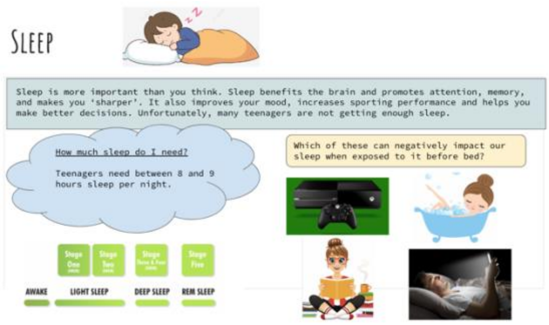
Description of Learning Activity / Teacher Activity

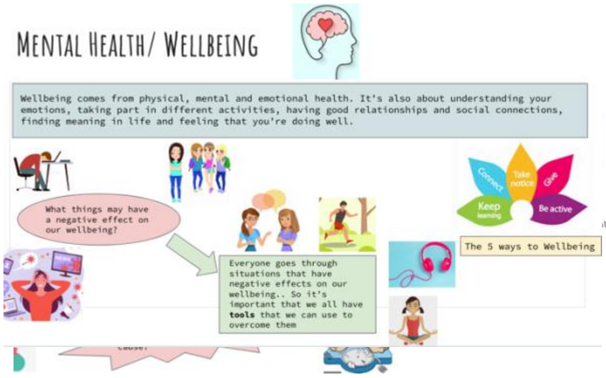
-The teacher explains that the class will be focusing on 6 main health topics for the first part of this program. 6 objects/pictures are displayed in front of the classroom to represent each health topic (e.g a pair of runners, a pillow, a food item etc). Students must guess what health topic each one represents. The teacher asks each group to identify one of the health topics based on the object. Points are awarded to groups who successfully identify each item.
-Teacher displays a small video/presentation on each topic, it briefly explains what each factor is and some healthy tips for each one (e.g 8+ hours sleep, 5-a-day etc). **8 mins**
-Jigsaw Match-up Game: each student is given a piece of a jigsaw with either a) a more positive or a more negative health behaviour associated with one of the vignettes (e.g eating healthy, taking drugs, not getting enough sleep, exercising everyday etc) or b)a health benefit/consequence of this behaviour (e.g being overweight, not being able to concentrate in school, having a good cardiovascular fitness level etc). The health behaviour of the named vignette must be matched to a benefit/consequence of this behaviour. Students must find which one of their peers has their corresponding jigsaw piece (only one side of the jigsaw will have the vignette's name on it). Multiple jigsaw pieces can match. **12 mins**
-After everyone thinks that they have found their corresponding jigsaw piece, the teacher presents what the answers could be on the board. Highlight that different matches could be made.. The teacher can display a graph/statistics/research study on the board if needed to back up a point. Also use this time to briefly explain who Jay, Sarah etc are (i.e 'the vignettes') **8 mins**

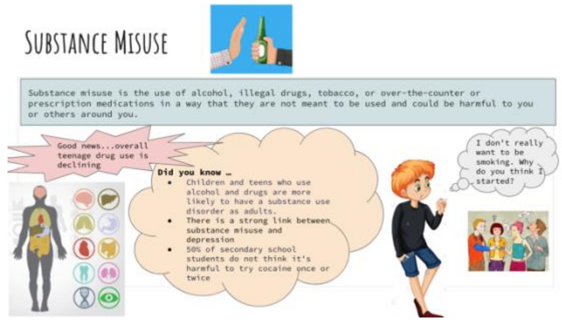
Conclusion / Closure of lesson **Time: 5**

Description of Learning Activity / Teacher Activity
-Students watch a brief video from the DCU Health Literacy team explaining why it's important for them to improve their level of health literacy. **2 mins**
-Individual goal setting: Why do you think it's important that you have a good level of health literacy? Each student writes down their 'why' clearly and colorfully on poster paper, they must bring this sheet with them to each HL class. **3 mins**

Lesson 1 Slides (8):







Lesson 3 (LifeLab recap) Plan:

Learning Intentions: We Are Learning To...

- Develop a deeper understanding of the terms health, health literacy, determinant of health and health behaviours
- Begin to understand the importance of critically assessing health information
- Become aware of what to look out for when determining the validity of a piece of health information
- Become more familiar with both poorer and better health behaviours associated with each topic

Success Criteria: What I'm Looking For...

- Students are able to define and understand the terms health, health literacy, determinant of health and health behaviours
- During an activity when students must find health information off the internet, they learn to only trust valid sources outlined by their teacher
- Students can detect when their peers are presenting 'fake' information to them
- Students get a deeper insight into both poorer and better health behaviours while they are given the task of researching a health topic

Introduction **Time: 10**

Description of Learning Activity / Teacher Activity

-Teacher takes the role and gives the class a brief overview of today's lesson

- Revision exercise: everyone has 2 minutes to write down their answer individually. They are asked to define 'health' and define 'health literacy'. In addition, they are asked to list the 6 health topics that they were focusing on in class/LifeLab last week. They then have 2 minutes to discuss this with a partner/small group to compare/edit their answers. Teacher then brings this together in a class discussion to ensure equal understanding. **5 mins**

Progression of Lesson **Time: 23**

Description of Learning Activity / Teacher Activity

-The teacher displays some questions on internet use. Can answer these individually or in their LifeLab groups using mentimeter/ kahoot etc. The teacher displays each anonymous reaction on the board. This can be done as a discussion if mentimeter/kahoot option not available. **3 mins**

-The teacher introduces the term 'fake news' followed by a 'Real or Fake' Game. Ask all students to stand up. Using the BBC Bitesize link, https://www.bbc.co.uk/bitesize/articles/z86xjsg there are 6 images and students have to guess if it's fake or real. If they believe it's fake, ask them to put their hands-on their heads. If it's real, they should put their hands-on their shoulders. Once everyone has guessed, click next and it will reveal if the story was fake or real. All the students who got it wrong should sit back down in their seats. **5 mins**

-Mini researchers game: Each group is given (or can choose) a different health topic to focus on (e.g sleep, PA, substance misuse, food choices, mental health). Using ipads/computers they each have 10 minutes to research what are good practices in and the health benefits/health consequences of their area. More advanced/older classes could use studies provided by the teacher. The teacher recommends for everyone to use valid websites/readings e.g WHO, Healthy Ireland etc. The aim is to find as many detailed, valid pieces of information in the given time. Groups should only include information if there is a little bit of science to back it up. Could assign two members of each group assigned the role of 'note takers' write down all the facts while the other group members search for information. **15 mins**

Conclusion / Closure of lesson **Time: 7**

Description of Learning Activity / Teacher Activity -The teacher shows the students a slideshow of a collection of common fake pieces of information seen on social media, netflix, food packaging and the internet. -At the end of the class, the teacher poses the question 'Based on the last 2 classes, what element of health literacy or health topic do you think you'd like to learn a lot more about?'. **3 mins**

Lesson 3 (LifeLab recap) Slides (15):

LIFELAB


TODAY'S AIMS:

1. UNDERSTAND WHAT HEALTH AND HEALTH LITERACY ARE
2. RECAP ON THE HEALTH TOPICS OF LIFELAB
3. START TO THINK ABOUT HOW WE JUDGE 'FAKE NEWS'
4. THINK ABOUT HOW WE CAN MAKE BETTER HEALTH CHOICES

1. WHAT IS HEALTH?
2. WHAT IS HEALTH LITERACY?
3. WHAT ARE THE HEALTH TOPICS WE FOCUSSED ON IN LIFELAB?

THERE'S LOTS OF OPPORTUNITY TO COMMUNICATE INFORMATION ABOUT HEALTH...

How many hours of YouTube content are viewed worldwide every day?

a) 100 million hours

b) 500 million hours

c) 1 billion hours

RECOGNISING FAKE NEWS AND IMAGES CAN BE HARD. A RECENT SURVEY OF YOUNG PEOPLE DID A SIMILAR TEST TO THE ONE WE'VE JUST DONE – AND ONLY 2% OF PEOPLE GOT ALL OF THE ANSWERS RIGHT.

HOW CAN WE SPOT 'FAKE NEWS'?

- **Source**
- **Headline**
- **Images**
- **Evidence**
- **Date & Byline**
- **Spelling & Grammar**

YOUR TURN TO BE THE RESEARCHERS...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WHERE DID YOU FIND YOUR INFORMATION?

DO YOU TRUST THE SOURCES?
DID YOU FOLLOW THE TIPS?

Appendix N: Adapted Version of the BREQ

BR(e)HQ for youth
Student ID (DCU will provide): TC21__________________
People can be healthy by doing all sorts of things, for example being active, making balanced food choice, getting enough sleep, and avoiding risky behaviours. The following statements have some reasons why you might make healthy choices. Please indicate how true each one is for you. All sentences start with "I try to be healthy because...".

1. I try to be healthy because...Being healthy is fun (intrinsic regulation)
   - ☐ Not true for me
   - ☐ Not really true for me
   - ☐ Sometimes true for me
   - ☐ Often true for me
   - ☐ Very true for me

2. I try to be healthy because…It is important for me to do healthy things (identified regulation)
   - ☐ Not true for me
   - ☐ Not really true for me
   - ☐ Sometimes true for me
   - ☐ Often true for me
   - ☐ Very true for me

3. I try to be healthy because…When I'm not healthy I feel bad (introjected regulation)
   - ☐ Not true for me
   - ☐ Not really true for me
   - ☐ Sometimes true for me
   - ☐ Often true for me
   - ☐ Very true for me

4. I try to be healthy because…Other people say I should be healthy (external regulation)
   - ☐ Not true for me
   - ☐ Not really true for me
   - ☐ Sometimes true for me
   - ☐ Often true for me
   - ☐ Very true for me

5. I try to be healthy because…I enjoy being healthy (intrinsic regulation)
   - ☐ Not true for me
   - ☐ Not really true for me
   - ☐ Sometimes true for me
   - ☐ Often true for me
   - ☐ Very true for me
6. I try to be healthy because…I value the benefits of being healthy (identified regulation)
   - ☐ Not true for me
   - ☐ Not really true for me

- Sometimes true for me
- Often true for me
- Very true for me

7. I try to be healthy because…When I don't do healthy things, I feel bad about myself (introjected regulation)
   - Not true for me
   - Not really true for me
   - Sometimes true for me
   - Often true for me
   - Very true for me

8. I try to be healthy because…If I'm not, other people will not be pleased with me (external regulation)
   - Not true for me
   - Not really true for me
   - Sometimes true for me
   - Often true for me
   - Very true for me

9. I try to be healthy because…I like being healthy (intrinsic regulation)
   - Not true for me
   - Not really true for me
   - Sometimes true for me
   - Often true for me
   - Very true for me

10. I try to be healthy because…In life it is important to be healthy (identified regulation)
    - Not true for me
    - Not really true for me
    - Sometimes true for me
    - Often true for me
    - Very true for me

11. I try to be healthy because…I want to show other people how healthy I am (external regulation)
    - Not true for me
    - Not really true for me
    - Sometimes true for me
    - Often true for me
    - Very true for me

12. I try to be healthy because…Other people pressure me to be healthy (external regulation)
    - Not true for me
    - Not really true for me
    - Sometimes true for me
    - Often true for me
    - Very true for me