Using intervention mapping protocol to develop a school-based intervention to enhance self-management among adolescents with type 1 diabetes mellitus.

Raya Al Habsi*

Higher Institute of Health Specialties, Oman

Abstract

Objective: To develop a school-based intervention to promote self-management among adolescents with Type 1 Diabetes Mellitus (T1DM) aged 11 to 15.

Method: This paper describes the development of a school-based intervention to enhance self-management among adolescents with T1DM through the first four steps of the Intervention Mapping protocol (IMP). Interviews were conducted with adolescents with T1DM to gain more understanding of their needs to enhance their self-management in schools. The findings were used to guide and shape the intervention by applying (IMP). Health care professionals were interviewed to provide recommendations about the scientific content and relevancy of the developed intervention. Finally, data regarding the appropriateness and acceptability of the developed intervention's content and materials were collected from adolescents with T1DM.

Results: The data collected from the interviews have identified specific information that, if known by peers and teachers, can reduce some of the physical and psychosocial challenges and consequently improve self-management among adolescents with T1DM in a school setting. The findings were used to develop an animated video. The results also indicated that the content of the developed intervention was relevant and appropriate to be used in schools.

Conclusion: The application of the IMP resulted in developing a well-informed evidence-based intervention, ready for pilot testing in the future that can enhance self-management in adolescents with T1DM in school settings.

Keywords: Diabetes insipidus, Type 1 diabetes mellitus, Youth, Teenager, Adolescents, Stressors, Challenges, School, Educational setting programme, Intervention mapping protocol.

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Introduction

T1DM is one of the most common endocrine-metabolic disorders in children and adolescents worldwide [1], corresponding to 5–10% of all chronic diseases in children and adolescents [2]. Total number of children and adolescents with diabetes in England refers to approximately 31,500 children and adolescents with diabetes under the age of 19 [3]. Physical, psychosocial, and emotional challenges play significant roles in adolescents' diabetes outcomes [4-6]. Diabetes care, in particular, is greatly influenced by these challenges when they affect adolescents' abilities to self-manage the disease and reach metabolic control [7]. Moreover, these challenges can increase the disease load and can cause even more distress, leading to an increased risk of diabetic complications. The school is a critical environment for adolescents with T1DM. Enhancing self-management in school is important in order to empower adolescents with T1DM in managing the day-to-day requirements of their disease. A systematic review conducted by Edwards D, et al. [8] concluded that school-based intervention involving nurses assisting with the case management and supervision of glucose and insulin dose adjustments, telemedicine and diabetes visit interventions might assist children and adolescents to self-manage some specific aspects of their T1DM in schools. Also, the review indicated that school-based intervention focused on the effectiveness of school personnel may help in educating and raising awareness amongst school staff and related health care professionals about T1DM, as well as improving communication channels between diabetes specialists. However, this review resulted in the identification that the school-based interventions developed to date have not attended to all the demands stated in previous studies; specifically, psychosocial aggravation has not been tackled. In addition, there is no clear indication of involving adolescents with T1DM in designing school-based intervention. Involving this age group when designing these interventions could enhance self-management skills. Another systematic review conducted by Pansier B, et al. [9] about school-based diabetes interventions and their outcomes confirms that there is a cumulative effort concerning school-based diabetes interventions. Though, the review accentuates that using a clear framework to develop school-based interventions is important in order to achieve the desired outcomes. Thus, the main aim of the paper is to develop a school-based intervention using IMP to promote self-management (i.e., physical or psychosocial) among adolescents with T1DM.

Methods

The Intervention Mapping Protocol (IMP) provides a structured framework to develop, implement, and evaluate complex interventions. It describes a process for developing theory-based and evidence-based health education programmes. The IMP framework was used to guide the development of the intended

intervention. The development of a relevant intervention is a very complex process, so the IMP framework was used to direct the intervention development [10]. De Craemer M, et al. [11] state that an IMP is a time-consuming process but this systematic approach may lead to an increase in intervention effectiveness. The framework consists of six steps: 1) need assessment, 2) preparing matrices and change objectives, 3) choosing theory-informed intervention methods, 4) creating intervention components, 5) programme adoption and implementation and 6) programme evaluation. Step 1 to step 4 of the IMP process used to produce the animated video was discussed in this paper. Step 5 and step 6 of IMP (adoption, implementation and evaluation) are beyond the focus of this paper.

IMP step 1-need assessment

The need assessment was conducted via a literature review and semi-structured interviews with adolescents with T1DM. The literature review was done to provide information about the prevalence of T1DM in adolescents, stressors facing adolescents with T1DM in school and how these stressors affecting the self-management in a school setting. Also, the literature review was conducted to provide information about the existing school-based diabetes interventions. The review revealed that the prevalence of T1DM is increasing among adolescents [12-14]. Adolescents with T1DM are facing extra challenges with experiencing all the rapid physical, psychosocial and cognitive changes while trying to maintain good metabolic control [15,16]. Also, adolescents are facing physical and psychosocial difficulties that can lead to poor management in school [17-19]. School-based interventions established previously predominantly centered around enhancing education/communication and care coordination for both students with T1DM and school staff. No intervention focused on diabetic knowledge among the school peers. Also, other aspects such as psychosocial and emotional challenges were not presented in the school-based interventions. Moreover, there was no clear indication of involving the voice and priorities of adolescents with T1DM during the development of school-based interventions [8,10].

The semi-structured interviews were conducted to explore needs and priorities for adolescents with T1DM in the school settings and to understand how adolescents wanted to be supported in schools to enhance their diabetic self-management. The results indicated that adolescents with T1DM are still facing physical and psychosocial challenges that negatively influence their self-management in school. The findings also suggested how adolescents with T1DM wanted to be better supported in school. Most of the participants felt that their teachers as well as their peers needed to gain more understanding of T1DM and its management.

All participants felt that enhanced knowledge and understanding of T1DM and its management among their teachers and peers could help to reduce psychosocial challenges and consequently promote their self-management. These findings influenced the intervention development, specifically the content. The interviewed adolescents with T1DM suggested specific knowledge that should be included in the intervention as follow; information about diabetes mellitus and its causes, information about the differences between T1DM and T2DM, information about signs and symptoms of hypoglycaemia to act on in an emergency, knowing that fluctuation of blood sugar can cause mood swing, knowing to remind someone with diabetes to check their blood sugar if their behaviour has changed, information about insulin pens, information about insulin pump, information about the need to eat in class, information about the importance of carrying the diabetes bag, knowing that teachers can give emotional support, knowing about a student with diabetes in the class will help a student with T1DM not to repeat information about themselves over and over, information about teachers to keep a register for students with diabetes, information about how hypoglycaemia should be treated immediately, information about how PE teachers can support a student with T1DM during a PE lesson and information about the importance of providing nutritional information.

IMP step 2- identify the outcomes and change objectives

Results from IMP step 1 were used to identify the intervention objective. The programme objective was formulated for the organisational level (peers and teachers in the school environment). The overall aim of this intervention is to enhance self-management of adolescents with T1DM in school through improving the knowledge and understanding about T1DM among school peers and school teachers. This step of the intervention mapping involves firstly, a specification of objective that include a clear description of the target population's behaviours. The finalised programme objective for the organisational level is: To Improve peers and teachers' knowledge and understanding of T1DM and its management. Secondly, objectives must specify what individuals (peers and teachers) need to learn to change their behaviour and what the expected changes are [20].

Based on the programme objective, different performance objectives were formulated at the organisational level of peers and teachers. An overview of the programme objective and performance objectives can be found in Table 1. Thirdly, after all, performance objectives were formulated for the organisational level (peers and teachers at school environment), the personal determinants for peers and teachers to improve knowledge and understanding of T1DM were listed (Table 2). The following section describes how learnings from the literature review were used in the intervention development. In addition, the search for determinants and associations with teachers and peer's knowledge of T1DM was explained. The background and literature review helped the authors to identify the health problem by identifying the prevalence of T1DM among adolescents and whether this specific group (adolescents with T1DM) has additional burdens due to the disease.

The literature review also provided an understanding of the impact that T1DM has on school-going adolescents with T1DM's quality of life. In addition, the behavioural and environmental factors that lead to poor management when it comes to school-going adolescents with T1DM were also ascertained, as well as an understanding of the behavioural and environmental contributors related to poor self-management. This information guided the intervention development by first isolating the problem of interest that the intervention should focus on (poor

Table 1. *Programme and performance objectives for the organizational level.*

Level Of The Intervention	Target Group	Program Objective	Performance Objectives
Organizational level	Peers and teachers at the school environment	To improve Peers and teachers' knowledge and understanding about T1DM and how it is managed.	1. Peers and teachers know the difference between type 1 diabetes and type 2 diabetes.
			2. Peers and teachers correct the misconception about the causes of T1DM.
			3. Peers and teachers recognise the causes, signs and symptoms of hypoglycaemia.
			4. Peers and teachers know what to do if someone develops signs and symptoms of hypoglycaemia.
			5. Peers and teachers understand the effect of hypoglycaemia on the mood of someone with diabetes.
			6. Peers and teachers recognise the causes, signs and symptoms and treatment of hyperglycaemia.
			7. Peers and teachers understand the different modalities of insulin therapies (injection-pens-pump)
			8. Peers understand the main diabetic tasks and why a student with T1DM carries their diabetic bag.
			9. Peers and teachers understand that a student with T1DM needs some time to eat in class to treat their hypoglycaemia.
			10. Teachers keep and maintain a register with all students who have diabetes.
			11. Teachers will support students with diabetes emotionally
			12. Physical education teachers remind students with T1DM to check their blood sugar before, during and after sport.

Table 2*. Selected determinants and related theories.*

Determinants Of Peers And Teachers	Related Theory
Self-efficacy	Social cognitive theory
knowledge	Health belief model
Attitudes	Health belief model
Social influence	Theory of planned behavior

self-management among adolescents with T1DM), and it helped to narrow down the context in which the proposed intervention needs to be developed (school settings). The literature review also provided a more thorough understanding of the school-based interventions that have been developed to date. The results of previous intervention research studies conducted in schools were explored with regards to their focus. They mainly centered on enhancing diabetic knowledge among school staff and school nurses; there were no interventions targeted at school peers.

In addition, previous intervention research studies focused on enhancing collaboration/communication among caregivers and assisting children and adolescents in managing some aspects of their diabetes. There was no focus on other aspects such as the psychosocial challenges that have been described in research studies. The literature review also showed a lack of involvement of the population at risk (adolescents with T1DM) when designing school-based interventions to understand more about their perspectives and needs. The viewpoint of adolescents with T1DM is critical for developing effective interventions. This gap in the literature helped to determine the fact that adolescents with T1DM needed to be included when developing the intervention in order to develop specific intervention components that are consistent with these adolescents' needs and perspectives.

The literature review on school-based interventions provided minimal understanding of how intervention developers translated their theory into school-based interventions. In addition, there were no details about the usage of specific frameworks to guide intervention development. Intervention developers rarely provide a clear theoretical basis for developing an intervention. Most of the time, they do not even describe the intervention in detail or address the issue of why or how it is expected to bring about the desired change. This gap helped to determine the use of a clear theoretical framework to create a well-designed, theory-driven intervention to allow a greater level of understanding of how the intervention might affect the target population.

A variety of factors influence health status, and these are known as determinants. These determinants can be classified as personal, social, economic, and environmental. Personal determinants are those factors that rest within individuals (agent in the environment). These factors can be changed or influenced by an intervention that involves how people think or have the capacity to change their behaviour. Personal determinants usually include cognitive factors such as knowledge, attitudes, or self-efficacy. The various determinants are not independent of each other; for example, knowledge is the basis for many other determinants such as attitudes and self-efficacy. The determinants and the related theories were identified from the literature. To identify these determinants, a review of the literature was undertaken to find empirical studies, theoretical concepts related to the topic, and general theories that include some of the identified determinants as constructs within those theories [20].

In order to come up with an appropriate set of evidence and

theory-informed determinants, the process started with asking questions, generating lists of answers, and validating these answers against the literature. The researcher asked questions like: what are the environmental factors that contribute to the presence of the problem and why would people perform the performance objectives, or why would certain environmental agents make environmental modifications. Then, the researcher undertook a review of the literature to find studies and theoretical concepts associated with the topic at hand and theories that include some of the identified determinants. The literature review provided the researcher with the informed relationships that these personal determinants have with the behaviour of the environmental agents (teachers). The researcher included determinants that are well supported by literature and the determinants that have the strongest relationship with the behaviour as described in the following paragraphs.

Based on the literature search for school-based intervention, and targeted knowledge of school teachers, seven studies focused on improving school personnel's knowledge. Only three of the seven studies were reported as theory-based intervention studies. The studies by Husband A, et al. [21], Bachman JA, et al. [22] and Smith CT, et al. [23] are based on Bandura's theory (social cognitive theory). They assumed that in keeping with Bandura's theory of self-efficacy, knowledge and confidence would translate to a positive action with regard to caring for the student with T1DM. These studies reported changes in outcome measures of determinants of behaviour change (such as teacher's knowledge, teacher's confidence and attitudes towards caring for students with T1DM), while Bachman and Hsueh reported the use of Rogers' theory of diffusion of innovations in the development [22], implementation and evaluation of the intervention. Teacher's involvement within each study intervention was high as teachers were exposed to intervention components.

A systematic review by Kazemi S, et al. [24] evaluated the effectiveness of peers-based intervention in managing T1DM among children and adolescents. The setting of the studies was home, camp, clinic, or community. The review included five randomized controlled trials, two were trials pre-post, and one was a controlled trial. All studies included were theory-based, including social support theory, social learning and self-efficacy and problem-solving. The systematic review outcomes focus on knowledge, attitudes, self-confidence, self-efficacy and social support. Studies focusing on knowledge and attitudes showed that more support from peers could lead to better metabolic control and better adjustment to diabetes tasks. There was a positive effect on peers' knowledge in the self-efficacy of adolescents and children with T1DM. Positive impact on peers' attitudes showed a significant increase in self-esteem and social acceptance for adolescents with T1DM. Also, La Greca AM, et al. [25] and Wysocki T, et al. [26] found that there is an encouraging relationship between social support and its influence on diabetes health outcomes indicated that friends provide social support distinct from parents' contribution and provide an important source of emotional support.

The provision of this support appears to improve adherence to self-management in general. They recommended that interventions aimed at involving friends in a positive, helpful manner seem to increase support from friends and to improve adolescents' self-management of diabetes. The determinants were selected based on their changeability and strength of the relationship with the behavior. For this intervention, the personal determinants selected for peers and teachers at the organisational level were: self-efficacy, knowledge, attitudes and social influence. The related theories which address these determinants were selected accordingly, as shown in Table 2.

The theoretical framework for the intervention

The theoretical framework of the present intervention consists of three theories: social cognitive theory, health belief model, and the theory of planned behaviour.

Social Cognitive Theory (SCT)

Bandura Social Cognitive Theory (SCT) is one of the most highly influential and widely celebrated theories in the field of social psychology. SCT is an interpersonal theory that involves together determinants of behaviour and the process of behaviour change. SCT describes a person's behaviour as a model of reciprocal determinism. Both behavioural and environmental factors work as interrelating determinants of each other [27]. SCT suggests that whether a person will change behaviour depends on self-efficacy, goals, and outcome expectations. If individuals have a great level of confidence, they can change even when they are confronted with many obstacles. If they are not confident about the behaviour in question, they was less motivated to act or to persevere through obstacles or challenges as they arise.

Behavioural capacity described in SCT refers to a person's actual ability to perform a behaviour (improved knowledge and understanding) through essential knowledge and skills to successfully perform a behaviour. A person must know what to do and how to do it. Self-efficacy refers to the individual's belief in his or her ability to perform and succeed in specific situations or activities, and the individual's confidence that he/she can change his/her behavior. According to Bandura A, et al. [28], people with greater levels of self-efficacy was more likely to engage in a specific behaviour, carrying on until they manage it and maintain the behaviour. The concept of self-efficacy has been among the most studied concepts in diabetes school-based intervention studies. According to Bandura A, et al. [28] individuals form self-efficacy beliefs by interpreting information regarding their capabilities.

Self-efficacy is an important factor influencing diabetes management behaviours either for patients or the care providers [29,30]. Social cognitive theory is useful in conceptualising strategies to enhance support from peers and teachers towards adolescents with T1DM. Setting realistic goals when aiming at changing behaviour (i.e., improve knowledge and understanding of T1DM and its management) can increase the peers' and teachers' sense of self-efficacy. Knowledge about T1DM can improve confidence among peers and teachers, and this could be translated into positive behaviour (action) in regard to better supporting adolescents with T1DM to enhance their self-management in school; for example, allowing the student

with T1DM to eat in the class if he/she needs to, without asking them to spit the food out, or being able to support students with T1DM during hypoglycaemia.

Health Belief Model (HBM)

Health Belief Model (HBM) has been used in a wide range of health-related contexts [31]. HBM found to be effective in improving the knowledge and attitude toward health issues [32]. Originally HBM consists of the following psychological concepts: Perceived susceptibility, Perceived severity, Perceived benefits and Perceived barriers. Also, according to HBM, decision making is triggered by cues to action, which may be internal such as disease or external such as health education message or a friend with the disease [20]. In this intervention, the researcher suggests that perceived susceptibility refers to the teachers and peers believe that they have a lack of knowledge about T1DM and its management. Perceived severity refers to the peers and teachers believe that their lack of knowledge can hinder or delay the self-management of adolescents with T1DM in school, which can lead to serious diabetic complications.

Perceived benefits refer to the teachers and peers believe that more knowledge and understanding might help to enhance self-management among adolescents with T1DM in school. Perceived barriers refer to the personal barriers of teachers and peers in understanding more about T1DM, such as lack of available educational resources. Cues to Action refer to teachers and peers receive reminders for the action needed, which is more knowledge about T1DM. In later application of HBM, researchers incorporated the concept of self-efficacy. In this intervention, self-efficacy suggests that teachers and peers are confident in supporting adolescents with T1DM in schools by receiving appropriate information about T1DM.

Theory of Planned Behaviour (TPB)

The Theory of Planned Behaviour (TPB) is based on the assumption that individuals usually behave sensibly, that they take into account the available information and implicitly or explicitly consider the implications of their action [33]. TBP suggests that intention is the most important determinant of behaviour. Ajzen I [34] elaborated that, according to TPB, intentions and behaviours are the foundation of three main determinants: attitude, subjective (social) norms, and perceived behavioural control. The attitude toward the behaviour is determined by salient beliefs about that behaviour. Each behavioural belief links the behaviour to a certain outcome or to an attribute. The construct of subjective norms (perceived social expectations) is a function of beliefs by people that specific, important individuals or groups (social influence) approve or disapprove of their performance of behaviour and how important that opinion is to them [20].

Social influence is important within the TPB and dismisses the belief that norms cannot play a steadily impactful role in the relationship between attitudes and action [35]. The final determinant is perceived behavioural control, which refers to an individual's perception of their ability to perform a given behaviour. It is assumed that perceived behavioural control is determined by the total set of accessible control beliefs. Perceived behavioural control is believed to moderate the relationship between intention and behaviour, i.e. intention will convert to behaviour when perceived behavioural control is high [36].

In general, individuals intend to perform the behaviour if they have evaluated it positively, when they experience social pressure to perform it and when they have the chance to do it. However, the theory assumes that the relative importance of the attitudes toward the behaviour, subjective norm, and perceived behavioural control depends on the intention under investigation. In some instances, only one or two of the determinants are needed to clarify the intention. The theory has been successfully used with other health behaviour changes' educational interventions such as improving oral health knowledge [37] and educating teens to improve dietary and physical activity-related behaviours [38]. The TBP has been found useful to guide diabetes self-management and diabetes education programmes [39].

Daley BJ [40], Pendley JS, et al. [41] and Békési A, et al. [42] found that peers' attitudes towards diabetic self-management influence adolescents' diabetic outcomes positively. They found that knowledge about T1DM led to a positive attitude and consequently higher peer support. The effect of knowledge on peers' attitude change resulted in better understanding and greater support. These findings highlighted the important role of knowledge on peers in attitude formation and attitude change toward supporting adolescents with T1DM, as well as the necessity of considering the determinants of attitude in this study.

For this intervention, social cognitive theory, health belief model, and the theory of planned behaviour are applied as a basis for the intervention. These theories are based on the concepts of self-efficacy, knowledge, attitudes and social influence. After selecting the theoretical framework for this intervention, the performance objectives were crossed with the determinant and resulted in the change objectives. The formulated change objectives were stated with an action word, followed by a statement of what is expected to result from the intervention. A matrix for the organisational level is shown in Table 3.

IMP step 3- choosing theory-informed intervention methods and practical approaches

Theory-informed methods are the techniques used for influencing changes in determinants that are selected for the targeted group (peers and teachers). Methods of the theory that is capable of influencing changes in the determinants were chosen during the third step of the IMP. First, all determinants included in the matrices at the organisational level were listed and were matched with methods derived from a theory. These methods were carefully considered for use in the intervention. For example, the formulated change objective 'Peers and teachers express confidence in their ability in recognising hypoglycaemia causes, signs and symptoms' was the result of crossing the performance objective 'Peers and teachers recognise the causes, signs and symptoms of hypoglycaemia' with the determinant 'self-efficacy'. The selected theoretical method that corresponded with the determinant 'self-efficacy'

to reach the change objective was 'verbal persuasion'. After the theoretical method was chosen, theoretical parameters and characteristics of the context were checked, and the selected method was translated into a creative application (Table 4). The summary of the theoretical method provided by Eldredge LK, et al. [20] was used to complete this selection process.

Table 3. *Matrix for peers and teachers at the organizational level (school).*

Performance Objectives (Peers And Teachers)	**Personal Determinants**			
	Self-Efficacy	**Knowledge**	**Attitudes**	**Social Influence**
PO.1. Peers and teachers know the difference between type 1 diabetes and type 2 diabetes.	Peers and teachers express confidence in differentiating between T1DM & T2DM.	Peers and teachers differentiate between T1DM & T2DM.	Peers and teachers express positive feelings about the importance of knowing the differences between T1DM & T2DM	Peers and teachers able to show concerns by knowing more about T1DM even if others do not show
PO.2. Peers and teachers correct the misconception about the causes of T1DM	Peers and teachers express confidence that they understand the cause of T1DM.	Peers and teachers know that the cause of T1DM is pancreas dysfunction.	Peers and teachers express positive feelings about the importance of understanding the cause of T1DM.	Peers stop annoying students with T1DM that they have diabetes because they eat too much sweet or they are overweight even if others do.
PO.3. Peers and teachers **recognise** the causes**,** signs and symptoms of hypoglycaemia	Peers and teachers express confidence in their ability in identifying hypoglycaemia causes, signs and symptoms	Peers and teachers list different causes, signs and symptoms of hypoglycaemia	Peers and teachers express positive feelings about the benefits of recognising causes, signs and symptoms of hypoglycaemia.	Peers and teachers can recognise someone with symptoms of hypoglycaemia. even if others do not do
PO.4. Peers and teachers know what to do if someone develops signs and symptoms of hypoglycaemia	Peers and teachers express confidence in the ability to respond to someone with symptoms of hypoglycaemia	Peers and teachers describe ways to help someone with hypoglycaemia .	Peers and teachers express positive feelings about the necessity and benefits of helping someone with symptoms of hypoglycaemia	Peers and teachers are encouraged to support and act assertively and efficiently if someone develops hypoglycaemia. Even if others do not support
PO.5. Peers and teachers understand the effect of hypoglycaemia/ hyperglycaemia on the mood of someone with diabetes.	Peers and teachers express confidence that they understand that blood fluctuation can cause mood swings and cause conflict	Peers and teachers describe the effect of blood sugar fluctuation on mood	Peers and teachers express positive feelings about understanding the fluctuating of blood sugar can avoid unnecessary conflict	Peers and teachers are more understanding and not getting angry; instead, they remind someone with T1DM to check their blood sugar gently. Even if others do get angry and don't remind students with T1DM.
Performance objectives (Peers and Teachers)	Personal determinants			
	Self-efficacy	Knowledge	Attitudes	Social influence
PO.7. Peers and teachers understand the different modalities of insulin therapies(pens-pump) and blood monitoring	Peers and teachers express confidence in the ability to describe different modalities of insulin therapy	Peers and teachers list different modalities of insulin therapy	Peers and teachers express positive feelings about the importance of knowing different modalities of insulin therapy.	Peers are not staring when a student with diabetes take an injection or check blood sugar. Peers give more space and don't ask many questions even if others stare. Peers and teachers are not confused about insulin pump to think it is MP3 or iPod.
PO.8. Peers understand the main diabetes tasks and why a student with T1DM carries their diabetic bag.	Peers express confidence about knowing why a student with diabetes carries their diabetes bag.	Peers describe what is inside the diabetic bag. Peers describe why a student with diabetes carries their diabetic bag.	Peers express positive feelings of taking care of the diabetes bag for a student with diabetes and not throwing it around.	Peers do not bully someone with diabetes and throw their bags even if others do.
PO.9. Peers and teachers understand that a student with T1DM needs some time to eat in class to treat their hypoglycaemia.	Peers and teachers express confidence they understand why students with diabetes need to eat a snack in class sometimes	Peers and teachers state situations where students with diabetes need to have a snack in the class.	Peers and teachers express positive feelings of the importance of student with diabetes to eat a snack in class.	Peers would not be surprised if a student with diabetes has to eat in the class sometimes, even if others were surprised Teachers will encourage a student with hypoglycaemia to eat in the class if needed. Even if other teachers do not encourage

PO.10. Teachers keep and maintain a register with all students who have diabetes.	Teachers express confidence in the ability to maintain records about the students with diabetes.	Teachers list the students with diabetes.	Teachers express a positive feeling that keeping a record of students with diabetes can help them not to forget about them and their individual needs.	Teachers was able to remember why students with diabetes have to do some tasks without asking them to repeat about their condition over and over even if other teachers do not remember.
PO.11. Teachers will support students with diabetes emotionally	Teachers express confidence in the ability to give emotional support.	Teachers know that they have to give emotional support to students with diabetes.	Teachers express positive feelings about giving more emotional support to students with diabetes.	Teachers are encouraged to give emotional support to students with diabetes. Even if other teachers do not give emotional support.
PO.12. Physical education teachers remind students with T1DM to check their blood sugar before, during and after sport.	Physical education teachers express confidence in the ability to support students with diabetes before, during and after sports activities.	Physical education teachers describe what to do for students with diabetes before, during and after physical education class.	Physical education teachers express positive feelings about the importance of checking blood sugar before, during and after sport.	Physical education teachers encourage students with diabetes to check blood sugar before, during and after sport. Even if other PE teachers do not encourage students with T1DM to check their blood sugar.

Table 4. *The theoretical methods and applications for attaining the change objectives at the organizational level.*

Level Of The Intervention	Determinant	Change Objective	Method	Related Theory	Application
Peers	Self-efficacy	1 - 9	Verbal persuasion	SCT	video
Teachers		1-7, 9-12			
Peers	Knowledge	1 - 9	Consciousness raising (providing information)	HBM	Elements of the same video
Teachers		1-7, 9-12			
Peers	Attitudes	1 - 9	Consciousness raising (providing information)	HBM	Elements of the same video
Teachers		1-7, 9-12			
Peers	Social influence	1 - 9	Resistance to social pressure	TPB	Elements of the same video
Teachers		1-7, 9-12			

The methods were applied in this intervention including, first, verbal persuasion. Verbal persuasion is when other people are encouraged to perform a task – in other words, using messages that suggest that the participant possesses specific capabilities. Second, consciousness-raising or providing information that aims to enhance the knowledge and attitudes of the particular needs of a group of people. In this case, it is raising the consciousness of T1DM and its management among peers and teachers. Finally, resistance to social pressure, which stimulates building skills for resistance to social pressure – such as identifying symptoms of hypo- or hyperglycaemia or how to support someone with hypo- or hyperglycaemia. Applying these methods is hypothesised to change peers' and teachers' self-efficacy, knowledge, attitudes and social influence. All of these methods were derived from the theories that have been selected in IMP step 2. Next, these methods were put into practice by selecting a practical application that fitted with the theoretical methods and specific programme goals. This selection was guided by suggestions from a few participants in step one and suggestions from the literature review. A few participants highlighted an interest in using a video to explain T1DM and its management. Some other participants highlighted the use of posters and PowerPoint presentations to improve the awareness about T1DM among peers and teachers. Posters provide a logical and cost-effective way for communication. However, posters require reduced content as well as getting to the point. Selecting what has to be included or omitted is not always easy. In contrast, PowerPoint can produce better visual effects and leave a deeper impression. However, it can be dull, not interesting, contain lots of information and be boring [43].

On the other hand, videos can become a powerful technological tool in education. Several benefits of using videos are reported in the literature. Lopes AP, et al. [44] explained that video could present in a clear and remarkable way descriptions to convey tacit information and knowledge that is hard to describe through text. The creative application for this intervention is a whiteboard animated video that can be used by peers and teachers. Whiteboard animation includes simple and yet engaging videos that show someone drawing images on the whiteboard. In this intervention, the video is combined with a voiceover to make the presentation even more informative and interesting. It is one of the new emerging sources for engaging a potential audience with less span of time, although some studies in the field of media psychology have shown that recipients can deal with media-based information with noticeable ease regardless of whether they are in the form of static pictures and photographs or dynamic movies and video clips [45].

However, Skouteris H, et al. [46] found that watching the animated video can improve understanding and grasping of information. Jones S, et al. [47] and Lowe R [48] explained that animations could show situational dynamics clearly, and can help recipients build comprehensible, high-quality mental models of complex change processes. Animation, consequently, may be anticipated to enhance learning, especially when illustrating dynamic processes, as motion is shown to be more visually explicit, thus reducing cognitive processing. De Lepeleere S,

et al. [49] clarified other benefits of using videos, such as the 24-hour availability of information and the possibility to reach a broader audience and to raise access to organizations without an increase in the cost. Table 4 provides an overview of all the methods and applications (a video) that were selected and used to achieve the change objectives for the organizational level of the intervention.

IMP step 4-producing intervention components and materials

Step 4 utilized the information from the previous steps to develop the video. The intervention is developed specifically to be used in schools. In particular, the results of step one of (interviewing adolescents with T1DM) provided information on how adolescents with T1DM wanted to be supported by their peers and teachers. Thematic analysis of the data from step one directed the content and the information that needed to be included in the video. The organization or the flow of the information included was adopted from a school-based intervention developed by Siminerio LM, et al [50]. It targeted school personnel and showed significant improvement in staff knowledge. Their programme is entitled the '5Cs programme' and highlighted information on the causes, classification, complications, care, and cure of T1DM. The researcher followed the 5Cs only for the flow of the information as it shows the logical sequence of the information. However, the specific content was based on the thematic analysis from step one. All the scientific content is based on updated information from Diabetes UK, American Diabetes Association, IDF, NICE, and ISPAD.

The information was used by the researcher to draft a script that was then used to develop the animated video. To determine whether the script content is appropriate, the researcher reviewed the script content against the programme objectives. The match was almost perfect, and gaps were filled. Also, all the messages that needed to influence the change objectives were included (Table 5). For the video production, the researcher contacted the production company to agree to the contract. The contract and the budget included a rough cut of the video for the researcher's pre-testing, reviewing and approval. A rough cut is an initial edit of the production before final editing. The researcher pre-

Table 5. *Initial video content.*

Performance Objectives	Main Comment	Script
Introductory comments	Introductory comments about diabetes (how insulin is important for the body)	Diabetes is a permanent health condition that happens when the amount of sugar in the blood is too high because the body cannot use it properly. High sugar levels in the blood can cause serious health problems. After having a meal, the body starts to digest carbohydrates and breaking them down into sugar. Insulin, which is a hormone produced by a part of our bodies called the pancreas, helps to move the sugar out of the blood and into the body's cells to be used as energy for the body.
Peers and teachers know the difference between type 1 diabetes and type 2 diabetes.	Two main classifications of diabetes mellitus	There are two main types of diabetes: Type 1 diabetes and type 2 diabetes. These two types are entirely different from each other.
Peers and teachers know the difference between type 1 diabetes and type 2 diabetes	A brief introduction to Type 2 diabetes	Type 2 diabetes happens when the insulin does not work properly, causing sugar to build up in the blood. This type of diabetes can be treated by diet, exercise, or pills.
Peers and teachers correct the misconception about the causes of T1DM	Causes of T1DM	Type 1 diabetes does not happen because you are overweight or because you eat too many sweets. It happens to people because their bodies cannot make insulin at all because the cells that are producing insulin in the pancreas are damaged or destroyed. So, they will need insulin to allow their bodies to process sugar and avoid further complications from high sugar in the blood.
Peers and teachers understand the different modalities of insulin therapies(injections-pens-pump) and blood monitoring	The different modalities to treat T1DM (injection, pen, and pump)	The insulin can be taken by insulin injection, insulin pens or insulin pumps. Insulin pens include an insulin holder, a knob to measure insulin amount, and a one-use needle. The insulin pump is a small device used to continuously inject insulin. It is attached to the skin and can be easily carried on the belt or inside the pocket.
Peers and teachers recognise the causes, signs and symptoms of hypoglycaemia	Complications of T1DM: low blood sugar (hypoglycaemia)	Low blood sugar, also known as hypoglycaemia, is one of the complications of diabetes. It happens when blood glucose level goes too low
Peers and teachers recognise the causes, signs and symptoms of hypoglycaemia	Causes of hypoglycaemia	1. Skipping or delaying a meal. 2. Not having enough carbohydrates. 3. Doing a lot of exercise without having extra carbohydrate 4. Taking insulin more than needed
Peers and teachers recognise the causes, signs and symptoms of hypoglycaemia	The importance to act fast during hypoglycaemia, and signs and symptoms of hypoglycaemia	Hypoglycaemia can happen so quickly. So, it is very important to know its signs and symptoms and what to do if someone has a hypoglycaemia Feeling shaky, sweating, being nervous, getting angry, going pale, having a fast heartbeat, lips feeling tingly or numbness, blurred sight, feeling hungry, mood swings, tiredness, having a headache, and lack of concentration.

Peers and teachers understand the effect of hypoglycaemia/ hyperglycaemia on the mood of someone with diabetes.	How hypoglycaemia affects mood and what to do if a student with diabetes started to behave differently	Hypoglycaemia can also cause quick changes in a person's behaviour, which explains mood swings. So, if a student with diabetes starts to behave differently, please gently remind him to check his blood sugar.
Peers and teachers know what to do if someone develops signs and symptoms of hypoglycaemia	How to help someone with hypoglycaemia	It is important to act fast to avoid more complications. You can start by reminding the person to check his blood sugar. As a quick treatment, try giving food containing a small amount of carbohydrates. Here are some examples of foods containing carbohydrates: 1. Glucose tablets, 2. Fruit juice, 3. ½ cup of non-diet soft drink 4. Milk and DO NOT FORGET TO CALL FOR HELP FROM TEACHERS OR THE SCHOOL NURSE
Peers and teachers recognise the causes, signs and symptoms of hyperglycaemia.	Complications of T1DM- high blood sugar (hyperglycaemia)	High blood sugar, also known as Hyperglycaemia, is another complication of diabetes. It happens when the blood sugar level goes too high.
Peers and teachers recognise the causes, signs, symptoms, and treatment of hyperglycaemia.	Causes of hyperglycaemia	1. Not taking insulin 2. Having more food than needed 3. Stress 4. Sickness or feeling unwell 5. Doing exercises less than planned
Peers and teachers recognise the causes, signs, symptoms, and treatment of hyperglycaemia.	Signs and symptoms of hyperglycaemia	1. Frequent urination 2. Increased thirst 3. Blurred vision 4. Weakness and headache
Peers and teachers recognise the causes, signs, symptoms, and treatment of hyperglycaemia	How to treat hyperglycaemia	Normally, short time hyperglycaemia does not require an emergency or any immediate treatment. But if it stays high for a long time, it must be treated by drinking lots of sugar-free fluids or taking extra insulin.
Peers and teachers understand the main diabetes tasks and why a student with T1DM carries their diabetic bag.	Diabetes tasks (administration of insulin and checking blood sugar)	Diabetic students will need to have insulin pens with them. These pens contain medication used to control their blood sugar. They also have to prick their finger to test their blood sugar levels using a special blood sugar meter
Peers and teachers understand the different modalities of insulin therapies(injections-pens-pump) and blood monitoring	Do not be confused about insulin pump	Some diabetic students are using an insulin pump instead. It may look like an iPod!! So, do not be confused
Peers and teachers understand the main diabetes tasks and why a student with T1DM carries their diabetic bag.	Help student with diabetes to take care of his diabetic bag	It is very important for diabetic students to always have their diabetes medication bag with them. This bag contains their equipment and medication, so please help them to take care of it.
Peers and teachers understand that a student with T1DM needs some time to eat in class to treat their hypoglycaemia.	Eating during the lesson	Sometimes they will also need to have a snack during the lessons to keep their blood sugar at normal levels
Teachers keep and maintain a register with all students who have diabetes	Keep records of students with diabetes	It is so frustrating when diabetic students repeat about their condition over and over. So, it is much helpful if teachers can keep and maintain a register with their students who have diabetes.
Teachers will support students with diabetes emotionally	Teachers have to give emotional support	Diabetic students will need your emotional support as much as your academic support
Physical education teachers remind students with T1DM to check their blood sugar before, during and after sport	PE teachers to support students before, during and after sport	Physical education teachers to make sure of blood sugar levels of their diabetic students before, during, and after doing any physical exercises. This will avoid a student having sudden drops in blood sugar levels.
School canteen to provide nutritional information about the food they provide	School canteen to provide more information about the food that they provide	School canteens can also provide students with information on how many carbohydrates in each portion size of food they sell. This will help students with diabetes to adjust their insulin dosage accordingly.
	Closing remarks	Remember, Your help and support can make a massive difference in someone's life

tested a rough cut with the diabetes health care professionals (as explained below). After making the amendments suggested by a health care professional, the script was reviewed and compared with intended change objectives and sent for video production to be ready to be tested with adolescents with T1DM for their feedback. It is suggested that peers and teachers watching the

video will learn about T1DM and be aware of its management and be more supportive to the adolescents with T1DM and consequently self-management among adolescents with T1DM was much easier in schools. Furthermore, self-efficacy, knowledge, attitudes and social influence may be enhanced. Given that the peers and teachers watching the video will have no opportunity to discuss its content, the researcher considered it essential that the key messages were integrated explicitly in the script, and that video was educational and self-explanatory. The video was designed to teach explicit information related to T1DM and its management and how to support someone with T1DM in school.

Health care professional's consultation

Health care professionals with experience in treating and supporting adolescents with T1DM, drawn from paediatric-diabetic workers in the local NHS trust (e.g., paediatric- diabetic nurses, paediatric-diabetic physicians, paediatric psychologists, paediatric dietician), were interviewed. Interviews with the health professionals were considered after the development of the intervention. A brief report about the findings of step one was prepared. The report was presented to health care professionals, as well as the prototype of the developed intervention. The prototype of the intervention (video) was presented to the health care professionals using a laptop. They were instructed to stop, restart and turn forward and backwards at any parts of the video to give their comments. Face-to-face semi-structured interviews were conducted with the health care professionals, and they were asked to give their recommendations about the developed intervention based on their expert views. The participants gave their overviews about the developed intervention (video) based on their expert opinion and the data provided from step one. All participants agreed upon the video format (Whiteboard animated video), appropriateness of the included information, simplicity and usability of the video. However, the participants have suggested some modifications that were used to make the necessary amendments in the developed intervention. The amended intervention was shown to another group of adolescents with T1DM that didn't participate in step one to check the appropriateness of the produced intervention. All the modifications suggested by the participants are summarised in Table 6 below.

Based on the expert feedback, two objective performances have been added as follows:

1. Peers and teachers understand that complications of T1DM can happen for no obvious reason
2. Teachers recognise that students with diabetes have different preferences. Some will like to manage their diabetes in class, and some will prefer to go to the medical room.

After that, the theoretical methods and applications for the two added performance objectives have been selected and included in the table of theoretical methods and applications for achieving the change objectives at the organisational level, as shown in Table 7.

Feedback from adolescents with T1DM on the modified video

After modifying the intervention content based on the comments and suggestions provided by the health care professionals, a new group of adolescents with T1DM was recruited and interviewed using a semi-structured individual interview in

Table 6*.Modifications to the video suggested by health care professionals.*

Changes Suggested	Specific Alteration To The Video Content
Speed and pauses	The speed of the flow of the information was reduced, and more pauses was added
Add more information	More description about the insulin pump was added
Change some medical words to informal words	Hyperglycaemia was changed to high blood sugar Hypoglycaemia was changed to low blood sugar Urination was changed to peeing
Specify what low sugar is with a number	Information that hypoglycaemia is usually below four millimoles per litre was added
Change the term 'food containing carbohydrates'	'Food containing carbohydrate' was changed to 'food containing fast-acting sugar'
Remove low-fat milk as treatment of hypoglycaemia	Low-fat milk was removed
Remove information about the ordinary injection	Information about 1ml injection was removed
Remove the information about adjusting the insulin dosage before exercise	Information about adjusting insulin before exercise was removed
Add that hyperglycaemia can happen because of illness	Information that hyperglycaemia can happen because of illness was added
Add that treatment of hyperglycaemia should include not only taking more fluid but also having an extra dosage of insulin	Hyperglycaemia should be treated by having extra fluid, **and** extra insulin dosage was added
Change the term (diabetic students) to (someone with diabetes)	Any diabetic students term was changed to someone with diabetes
Add that fluctuation of blood glucose level can happen even if someone with T1DM does everything right	The statement explains that fluctuation of blood glucose level can happen even if someone with T1DM does everything right was added
Add something about understanding the differences in the preferences of where to manage diabetes tasks among students with T1DM	Statement to understand different preferences among adolescents with T1DM was added

Table 7. *Theoretical methods and applications for achieving the change objectives at the organizational level.*

Level Of The Intervention	Determinant	Change Objective	Method	Related Theory	Application
Peers	Self-efficacy	1–10	Verbal persuasion	SCT	Video
Teachers		1–8, 10–14			
Peers	Knowledge	1–10	Consciousness raising (providing information)	HBM	Elements of the same video
Teachers		1–8, 10–14			
Peers	Attitudes	1–10	Consciousness raising (providing information)	HBM	Elements of the same video
Teachers		1–8, 10–14			
Peers	Social influence	1–19	Resistance to social pressure	TPB	Elements of the same video
Teachers		1–8, 10–14			

order to inform the acceptability and appropriateness of the developed intervention. The modified intervention (video) was also presented to the participants using a laptop. The participants were instructed to stop the intervention or go forwards or backwards at any part of the intervention to give their comments. The adolescents with T1DM were asked to speak about their ideas regarding the intervention, such as what they like or dislike, what seems to be acceptable and usable. All participants have expressed their positive attitudes in regard to the appropriateness of the information, format, simplicity, appropriateness of speed and length and the usage of easy language. There was nothing that they disliked in the presented video. One participant has suggested adding information about T1DM not being contagious. They also suggested that this video can be shared during a tutor session, where they usually meet in the class as groups.

Results and Discussion

This article discussed the usage of the first four steps of the intervention mapping protocol to develop an evidence-based intervention to improve awareness about T1DM among teachers and peers in a school setting. The resource addresses prominent determinants that have been identified to enable knowledge and understanding of T1DM. To the researcher's knowledge, this is the first intervention to use an IMP to improve teachers' as well as peers' knowledge and understanding about T1DM in a school setting. Findings from the literature indicated the importance of supporting students with T1DM to optimise their self-management during school hours [8]. School teachers play an important role to support students with T1DM. Therefore, many studies focused on the education of school teachers about T1DM. Diabetes training and continuing education of school teachers have reported that school personnel have gained knowledge and improved their self-perceived ability to support students with T1DM [9].

A recent systematic review by Kazemi et al. revealed that peer-based interventions could help to manage diabetes [24]. The participants involved in the need assessment indicated the need for involving the teachers as well as peers in the process of diabetes education, as this could help to enhance diabetes self-management among adolescents with T1DM in school settings. Key determinants of improving knowledge and understanding among teachers and peers that have been found in the literature review include: self-efficacy, knowledge, attitudes and social influence. A video-based intervention was developed based on the needs and priorities of adolescents with T1DM and the literature review. IMP assisted with the development of the intervention that addresses elements that were suggested by adolescents with T1DM. A key characteristic of IMP is the determination of desired outcomes at the beginning of the planning process, which ensures these outcomes are focused on throughout the intervention development process.

The application of IMP resulted in an evidence-based intervention informed by the requirements of adolescents with T1DM in school. Theory- and evidence-based development interventions increase the likelihood of an intervention being effective [51,52]. However, following the IMP steps, although time-consuming, can ensure that the change objectives selected and which the intervention is targeting is appropriate and likely to be effective. Healthcare professionals and adolescents with T1DM positively valued the developed intervention. They suggested that the intervention is a promising education programme that could help to improve diabetes knowledge among teachers and peers in school. The diabetic health care professionals who participated have expressed their desire to use the intervention in their school visits as soon as it is ready.

Conclusion

A well-informed evidence-based intervention was developed by actively incorporating the specific knowledge about T1DM that has been suggested by the adolescents and the wider literature review. The relevance and appropriateness of the intervention's materials were verified by healthcare professionals and adolescents with T1DM. This article also outlines the conceptualization, design and development of an evidence-driven and theoretically-informed school-based intervention. The adolescents wanted an intervention that can enhance the knowledge and understanding of teachers and peers in school about T1DM. It is hoped this work has the potential to make a real difference to reduce some of the physical and psychosocial challenges among adolescents with T1DM and accordingly help to enhance their self-management in school.

This paper contributes by providing more insight into the systematic development of diabetic school intervention and a more detailed description of the behaviour change methods and strategies used. The developed intervention (video) is a rigorously researched intervention in terms of approach, content and construction. Although this intervention is developed based on theory and evidence, its effectiveness still needs to be evaluated in an evaluation study. Evidence from the evaluation study will provide information on the efficacy of the intervention. If the evaluation study proves that the intervention

is effective, a well-developed intervention wascome available for teachers and peers in school that might have an impact on teachers' and peers' understanding about T1DM.`

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***Correspondence to:**

Raya Al Habsi
Higher Institute of Health Specialties,
Oman