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The Importance of Different Knowledge Types in Health-Related Decisions—The Example of Type 2 Diabetes

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Abstract: Noncommunicable diseases (NCDs, e.g., type 2 diabetes) are a burden to humanity and hence addressed in the Sustainable Development Goals (SDGs) (target 3.4). One way of tackling NCDs is by health education as part of science education. Yet, the role of knowledge for health-promoting actions, and thus, the role of science teaching in health education, is not sufficiently clarified. Therefore, the author proposes to differentiate three knowledge types: System Health Knowledge (SK), Action-related Health Knowledge (AK), and Effectiveness Health Knowledge (EK). Accordingly, we designed a questionnaire that asked students to evaluate different questions about sugar consumption and type 2 diabetes according to their relevance for deciding their future sugar consumption. We found that students considered all questions as rather important (3–4.3, out of 5) with an assigned mean importance for SK with a mean of 3.8, for AK with a mean of 4.0, and for EK with a mean of 3.9. This research indicates that knowledge is important for decision-making and that all three types of knowledge should be recognized in health education.

Keywords: health education; science education; knowledge; decision-making

1. Introduction

1.1. Problem

Chronic or noncommunicable diseases (NCDs, e.g., cardiovascular disease, stroke, cancer, or type 2 diabetes) are "the leading cause of mortality in the world," and according to the World Health Organization (WHO), 80% of premature deaths attributed to NCDs could be prevented [1]. To meet this challenge, the UN Sustainable Development Goals (SDGs) include target 3.4: "By 2030, reduce by one-third premature mortality from non-communicable diseases through prevention and treatment and promote mental health and well-being" [2]. This target is specified, e.g., in indicator 3.41 "[m]ortality rate attributed to cardiovascular disease, cancer, diabetes, or chronic respiratory disease" [2]. Here, the nutritional status is crucial, since unhealthy diet (e.g., excessive sugar consumption) is a significant risk factor for NCDs [1]. Regarding type 2 diabetes, the number of people affected is increasing, especially in developed countries with western lifestyles [3], and "diabetes was the seventh leading cause of death in 2016" according to recent estimates [4]. Consequently, one of the "Grand Challenges and Opportunities for Science and Technology in the medium term Future" is the improvement of nutrition [5] (p. 8).

NCDs like type 2 diabetes have (besides genetic predispositions) physiological risk factors such as, e.g., overweight, and obesity and raised blood glucose. These physiological problems, in turn, can be favored by various behavioral risk factors, e.g., physical inactivity, and an unhealthy diet [6]. The last one is linked to the disproportional intake of fat, fruits, and vegetables as well as

sugar (e.g., in sugar-sweetened beverages [7]) and alcohol. On the one hand, the reasons for these behaviors are conditioned by the environment or setting and socioeconomic status. On the other hand, individual motivational factors (e.g., attitudes, needs, values) and, in many places, the role of knowledge, are discussed as potential causes for (un)healthy behavior [8] (Figure 1).

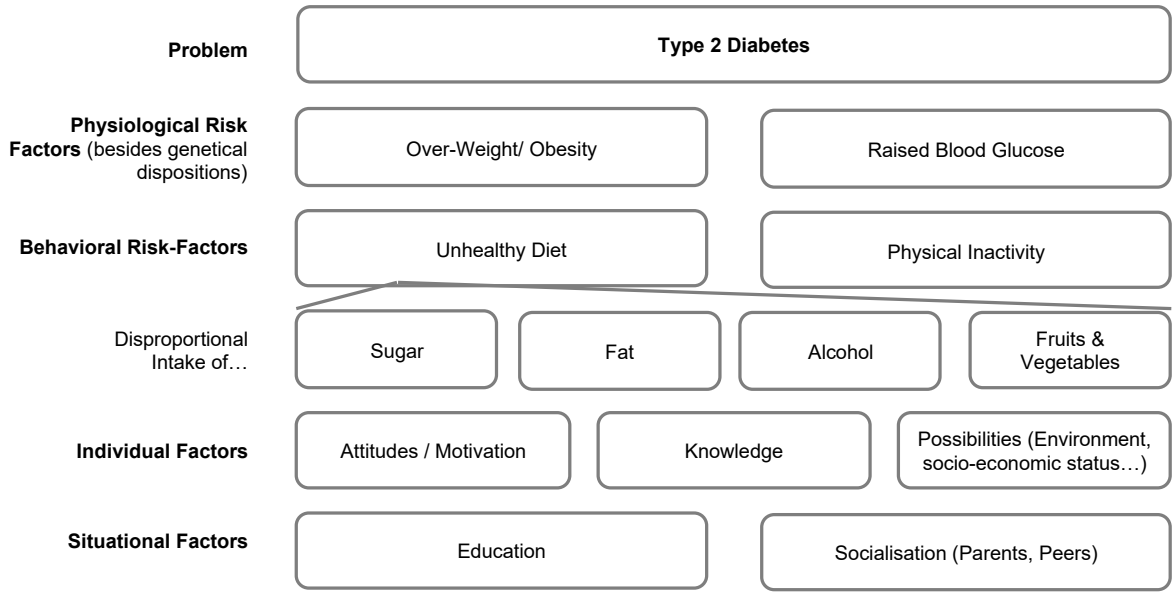

Figure 1. Schematic representation of possible causes of NCDs [6,9,10]. NCD: noncommunicable diseases.

For preventing premature mortality from NCDs, Cao et al. [9] suggest "[h]igh-level political commitments to effective and equitable national surveillance and prioritized prevention, early detection, and treatment programs tailored to the major NCD types" (p. 1288), especially in lower-resourced settings. In higher-income settings, access through prevention and education—namely health literacy—can also play a significant role. Consequently, it is essential to teach students how to make healthy decisions, especially regarding nutrition. However, how can people be encouraged to change their behavior, e.g., their diet? To find possible answers to this question, this paper focuses on the NCD "type 2 diabetes" and the risk-factor "unhealthy diet," especially in disproportional intake of sugar, especially free sugars (e.g., in sugar-sweetened beverages [7]). High sugar consumption can influence weight-gain overweight (simply because of the excessive calorie intake), which in turn can lead to insulin resistance. On the other hand, high sugar consumption can lead to high blood glucose levels, which can also lead to insulin resistance [10,11]. Nevertheless, it should be explicitly mentioned that type 2 diabetes is multifactorial and sugar consumption does not directly cause diabetes, as shown in Figure 1.

The WHO defines health promotion as "a process of enabling people to increase control over, and to improve, their health" [12] (p. 17). One of the priorities of health promotion lies in empowering individuals, which "demands more consistent, reliable access to the decision-making process and the skills and knowledge essential to effect change" [13] (p. 17). Accordingly, this paper takes a look at what role knowledge can play for making health-related decisions in this context. Since science and health issues can be of mutual benefit [14–16], science education can have a significant impact on preventing NCDs like type 2 diabetes. To figure out possibilities for prevention through (school-) education, this paper looks at the issue from a science education perspective.

1.2. Theoretical Background

Science education aims at enabling learners to make competent behavioral decisions in various science-related issues, e.g., in health issues. Health education, in turn, strives for enabling learners to "make informed decisions about their future lives and health" [17] (p. 99). These decisions can relate

to either individual or political behavior [18–20]. As a precondition for taking competent behavioral decisions on an individual level, the need for learners to develop an understanding of the concepts and principles within science is imperative [21]. Also, learners need to be able to reflect on the driving forces behind their own behavioral decisions and to recognize the role those decisions may have in the development of the abovementioned future challenges [18,22,23]. Health education has a long tradition in science and biology teaching, as scientific/biological facts, relationships, and principles play a central role in understanding organ functions and the body as a system. However, the role of knowledge for the following health-promoting action or the decision for this, and thus, the role of science and biology teaching in health education, is not yet sufficiently clarified [8].

Health action or behavior can be described as "(a)ny activity undertaken by an individual, regardless of actual or perceived health status, for the purpose of promoting, protecting or maintaining health, whether or not such behavior is objectively effective towards that end." [24] (p. 355). Hence, health action is deliberate and, accordingly, the action is based on cognitions and decision-making processes that lead to intention and, ultimately, action [25]. Health actions can be further divided into protective behavior (e.g., exercise or diet), risk behavior (e.g., smoking or drug use), or detection behavior (e.g., screening) [26]. In the context of this study, the focus is on protective behavior (including preventive behavior), and exemplarily nutritional behavior is discussed. Recent studies show that, e.g., German adolescents consume too much sugar and salt, too many fats, and high-fat foods, drink too much alcohol, and consume too little fruit and vegetables [27,28]. These behaviors are regarded as causes of NCDs such as obesity, diabetes, cancer, and cardiovascular diseases. Accordingly, health education should find ways to positively influence such behaviors in the long term [29].

It is essential to identify conditional factors for this behavior to promote positive behavior [30]. Research in health education is influenced by two research lines, social-cognitive and behavioral research (Health Behavior Change), which focuses on motivational factors of health action, and health literacy research, which focuses on basic education and knowledge [31]. On the behavioral research side, there are several international models explaining health action. Most of these models are prediction models that include several factors that are suitable for predicting health action. These models are called continuous, because a person can be assigned a certain probability of healthy action along a continuum [32]. The prediction models allow identifying factors that can be individually manipulated to promote healthy actions. Prominent examples of prediction models are the social-cognitive theory of Bandura (social-cognitive theory, SCT; [25,33]), the theory of reasoned action (TRA; [34]), and the theory of planned behavior (TPB; [35–37]), the model of health belief (HBM; [38,39]), the protection motivation theory (PMT; [40,41]) and the model of the health action process approach (HAPA; [32,42,43]). Research following this paradigm found that nutritional behavior is determined by attitudes and motivational factors towards nutrition [27,44]. Accordingly, different motivational factors can play a role in decision-making processes [23]; for example, perceived susceptibility and perceived severity of associated diseases (e.g., type 2 diabetes), efficacy expectations (e.g., concerning the reduction of sugar) and the personal evaluation of this action, as unpleasant, expensive, or stressful. Even more, the expectation that a particular action leads to the desired outcome (e.g., the prevention of type 2 diabetes) is not easy to calculate and prone to subjective assessments as well as the value of this outcome, not to forget the social norm, which, e.g., might lead one to eat sweets to be socially recognized.

In addition to motivational aspects, an essential role in the context of health actions is attributed to knowledge [15,45–47]. The numerous definitions of health literacy that describe the procurement, understanding, and use of information as the basis of health literacy [48] support the role knowledge has. However, the influence of knowledge on intention formation or directly on behavior, especially in the area of nutrition, has not been clarified yet, and findings about the role of information or knowledge, in decision-making (or intention formation) and action, however, are inconsistent [49,50]. There is a corpus of studies indicating that knowledge about nutrition issues is associated with behavioral intention and performance (e.g., [51–53]). Other studies, however, point to the exact opposite

(e.g., [54,55]). Reasons for this inconsistency can be found in the subject matter and its complexity, as well as in the process of human decision-making [56].

A lack of correlation can be attributed to a lack of specificity in the operationalization of knowledge and intention or action [34,50]. For example, it is conceivable that the measured correlation in the global issue of "healthy nutrition" is smaller than, for example, in "sugar consumption." Also, Worsley [50] argues that different types of knowledge (e.g., declarative and procedural knowledge) must be taken into account. Furthermore, he argues that it may not be possible to grasp the connections between knowledge and action because they are not directly present, but are mediated, for example, by motivational factors [50]. However, models that take into account different types of knowledge and integrate both knowledge and motivational factors in a meaningful way, so that mediation correlations can also be taken into account, are still lacking. Thus, an adequate description of the role of knowledge is not possible, and corresponding interventions in science and biology teaching based on knowledge transfer remain explorative. To make appropriate models usable for science/biology teaching and to avoid the danger of training action routines instead of promoting knowledge-based decision-making, Arnold proposed a model [23]. This model identifies different knowledge types and systematically places it in connection with well-established motivational factors. Here, Kaiser and Fuhrer [57] used a threefold division of knowledge underlying ecological behavior, which can be transferred to health behavior like, for example, sugar consumption ([23]; Figure 2):

1. *System Health Knowledge (SK)*, which is the "knowledge about health, the body, and its (mal-) functioning" [23]. It includes knowledge about the use of carbohydrates and how carbohydrates are metabolized in the body, the mechanisms and risk factors that lead to insulin resistance and type 2 diabetes, and the impact of type 2 diabetes on health. This knowledge might especially influence the evaluation of susceptibility and severity of coming down with type 2 diabetes (perceived health threat). Moreover, it influences the following knowledge types.
2. *Action-related Health Knowledge (AK)* is the "knowledge about possible actions to preserve functioning and prevent malfunctioning of body and health" [23]. It includes knowledge about recommendations about sugar intake, about foods that contain carbohydrates and sugars, and knowledge about actions to reduce the intake of sugar. This knowledge is hypothesized to influence the attitude towards health action.
3. *Effectiveness Health Knowledge (EK)*, which is the knowledge about the relative potential of actions that lead to the desired prevention of diseases [23]. It includes, e.g., the ability to decide on foods that contain less sugar. This knowledge is hypothesized to influence the attitude towards the health outcome.

The proposed three-dimensionality has been tested, and it was shown that health knowledge concerning the reduction of sugar consumption in favor of type 2 diabetes prevention could be treated as three-dimensional, hence consisting of SK, AK, and EK [56]. Since this three-dimensionality of health knowledge was derived from theory and adopted in a model for decision-making [23], it needs validation. The question arises whether learners perceive the three knowledge types as important for their decisions, too. In the presented study, we examined which knowledge students consider being relevant for health decisions, again using type 2 diabetes as an example. Hence, the goal of this study is to identify the ascribed importance of different health knowledge (dimensions) for decision-making processes. If students would not find all types of knowledge important, it would have a corresponding influence on the model, or at least on teaching according to the model. This study is therefore a first step towards validating this model with empirical evidence.

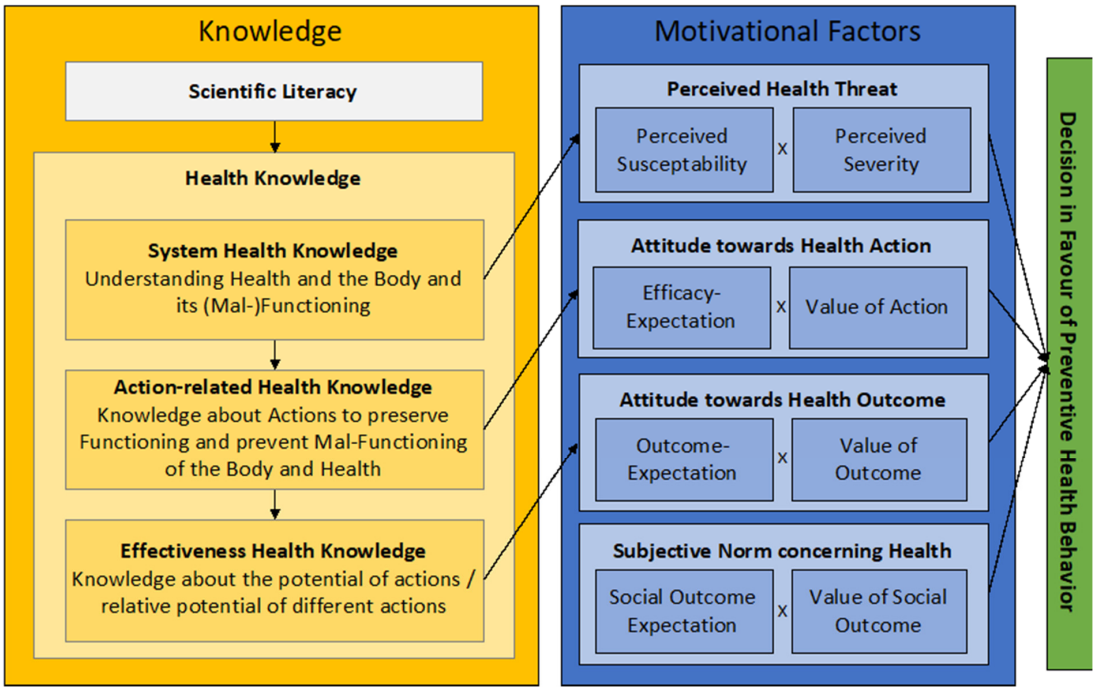

Figure 2. Integrated Model of Decision-Making in Health Contexts for Science Education [21] with possible correlations.

2. Materials and Methods

In the first step, we asked students ($N = 56$) from vocational school (mean age: 20.1; 91.07% female) via an open-ended questionnaire-item, what knowledge they would need to form a decision regarding their sugar consumption: *"Chocolate, gummi bears, cakes, and coke are delicious! However, too much sugar can lead to health problems. For example, it may be a cause of type 2 diabetes. Imagine that you should decide today if you wanted to reduce your sugar intake for one year to prevent type 2 diabetes. What information would you need for your decision? Write at least three questions that need to be answered for your decision."* Of these 56 students, 13 had a special relationship to biology, chemistry, or nutrition, e.g., through a subject or course of study. We chose this older and more-experienced sample, as it has been shown that younger pupils give few answers to these open questions. The answers were categorized inductively and deductively assigned to the three knowledge dimensions. For example, the students asked the following questions: "How is type 2 diabetes triggered?" "I should know what particular foods can cause this disease," "Where exactly is the problem, is it inherited or a real threat to me from my diet?", "How does type 2 diabetes get into my body?" or "How do I get type 2 diabetes?". These questions have been combined into the category "causes of type 2 diabetes" and attributed to the SK dimension.

Finally, the categories were formulated as questions in Likert-scale items, e.g., "What are the causes of type 2 diabetes?". Additionally, we added six items covering the SK concerning sugar and its processing in the (un)healthy body, because there were no such questions in the students' questions. Yet still, we wanted to see all the possible knowledge types of the model covered.

In a second step, the resulting quantitative questionnaire was used for the reported study. The questionnaire consisted of 34 items in three scales. This second sample consisted of students from the 10th grade ($N = 81$) of a rural city in southern Germany (mean age: 15.9; 56.10% female). The sample contained no diabetics, 11 vegetarians, no vegans, 2 persons with lactose intolerance and no persons with fructose or glucose intolerance or allergy. On a scale of 0 to 3, students described themselves as having little dietary experience ("My dietary experience is great"; 0.35), rather nutrition-conscious ("It is important to me to know what I eat and drink"; 1.81), rather health-conscious ("I live very health-consciously"; 1.63) and rather less sugar-consciously ("I take care to eat little sugar"; 1.30).

These students were asked to rate the importance of information for their decision-making on a six-point Likert scale (0 = unimportant, 5 = important; see Table 1).

Table 1. Scales and examples for Likert-scale items (the complete item set is presented in Table 2). Introduction: "Imagine that you should decide today if you want to reduce your sugar intake in the future to prevent type 2 diabetes. How important would the following information be for you?"

Scale	No. of Items	Cronbach's α	Examples
System Health Knowledge (SK)	15	0.92	What is sugar? What are the symptoms of type 2 diabetes? Why does my body need sugar?
Action-related Knowledge (AK)	15	0.94	What can I do to prevent type 2 diabetes? How can I reduce my sugar consumption? Which foods contain how much sugar?
Effectivity Knowledge (EK)	4	0.86	What is the likelihood that my sugar consumption will cause me to develop type 2 diabetes? What is the probability that I will develop type 2 diabetes if I reduce my sugar consumption?

Descriptive analyses were conducted (means and standard deviations for each question) to identify the ascribed importance of single health information for the decision-making process. This allowed for ranking the questions in terms of importance. Furthermore, means and standard deviations for the three knowledge types (scales) were calculated to describe their importance.

3. Results

The descriptive results are displayed in Table 2 and show the 34 questions sorted by their ascribed importance. As can be seen, the range of the attributed importance ranges from an average of 3–4.3 (with a maximum of 5) points. Accordingly, it can be assumed that the students surveyed find all the questions somewhat necessary when it comes to deciding on reducing sugar consumption. The six questions that have been added subsequently, which relate to sugar and its processing in the body, are among the least important questions. Then, we find a mixture of items from all three scales with the questions "What is type 2 diabetes?", "What can I do to prevent type 2 diabetes?" and "What are the causes of type 2 diabetes?" being the most important questions to be answered to form an intention to reduce one's sugar intake.

Table 2. Questions concerning sugar and type 2 diabetes and how important students think they are for forming decisions about reducing sugar intake.

Question	Scale	Importance	
		Mean	SD
How is sugar structured?	SK	3.02	1.31
What is sugar?	SK	3.23	1.23
Why does my body need sugar?	SK	3.49	1.19
What types of sugar are there?	SK	3.52	1.17
How is sugar processed in a healthy body?	SK	3.57	1.18
How effective are individual low-sugar alternatives to prevent the onset of type 2 diabetes?	EK	3.65	1.16
Which organs of my body are involved in sugar processing?	SK	3.69	1.10
Where can I find information on the sugar content of foods?	AK	3.78	1.16
Which types of sugar should I consume preferably?	AK	3.8	1.09
Are all sugars equally harmful?	AK	3.88	1.13
What influences my blood sugar level?	SK	3.89	1.08
How much sugar can I eat every day to stay healthy?	AK	3.89	1.08
How is sugar processed in the body if you have type 2 diabetes?	SK	3.89	1.08

Table 2. *Cont.*

Question	Scale	Importance	
		Mean	SD
What is the probability that I will develop type 2 diabetes if I reduce my sugar consumption?	EK	3.90	1.08
Which foods contain the least amount of sugar?	AK	3.91	1.18
To what extent should I reduce my sugar intake to prevent type 2 diabetes?	AK	3.94	1.05
What is the likelihood that I will develop type 2 diabetes if I reduce my sugar intake?	EK	3.96	1.16
What are the alternatives to sugar?	AK	3.96	1.21
What is the likelihood that my sugar consumption will cause me to develop type 2 diabetes?	SK	3.96	1.10
What role does sugar play in the development of type 2 diabetes?	SK	3.96	1.03
What are the consequences of type 2 diabetes for me and my well-being?	SK	4.02	1.11
Which foods contain how much sugar?	AK	4.04	0.97
Which foods contain the most sugar?	AK	4.06	1.14
What low-sugar alternatives are there?	AK	4.06	1.13
How can I reduce my sugar consumption?	AK	4.09	1.10
What are the consequences of reducing my sugar intake for my body?	EK	4.09	0.95
What types of sugar should I avoid?	AK	4.10	1.02
How high is my current sugar consumption?	AK	4.12	1.03
How does type 2 diabetes develop?	SK	4.22	0.99
What are the symptoms of type 2 diabetes?	SK	4.22	1.07
Which foods should I consume, preferably, and which should I consume in moderation to reduce my sugar intake?	AK	4.24	1.05
What is type 2 diabetes?	SK	4.27	1.00
What can I do to prevent type 2 diabetes?	AK	4.27	0.99
What are the causes of type 2 diabetes?	SK	4.31	0.97

Looking at the descriptive data of the knowledge scales (SK, AK, and EK; Figure 3), it can be seen that all three types of knowledge are assessed as rather relevant, since the mean values with a maximum number of five are each close to four with a standard deviation of less than one making (M_{SK} = 3.7, SD = 0.74; M_{AK} = 4.0, SD = 0.81; M_{EK} = 3.9, SD = 0.90). This means that, on average, the importance of the respective types of knowledge is estimated to be rather high for decision-making.

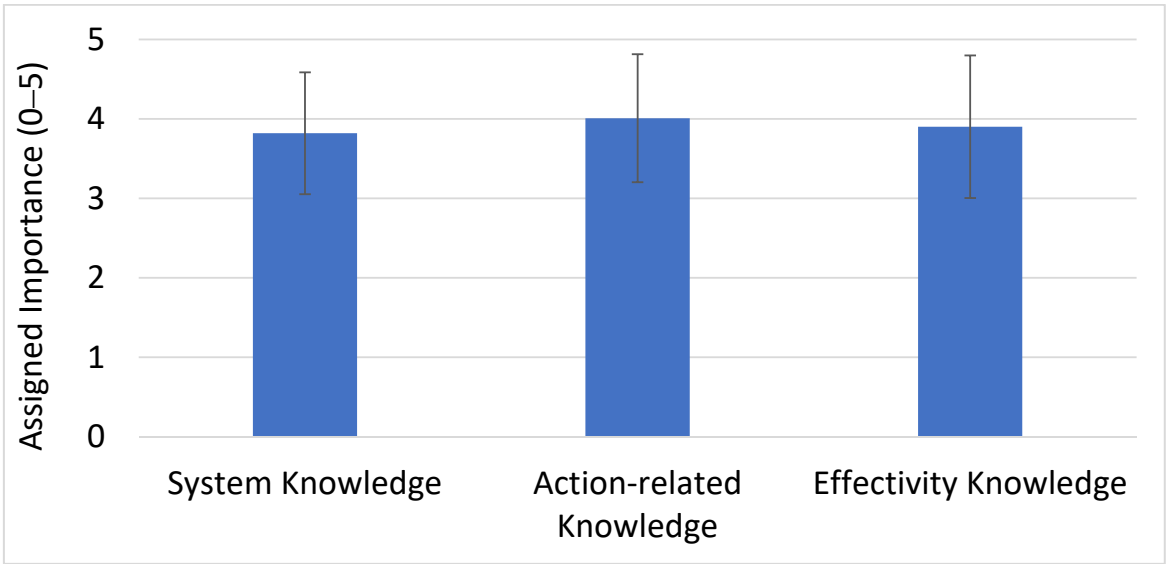

Figure 3. Students' answers to the questionnaire about the importance of knowledge for decision-making.

4. Discussion

This study shows that students think information is important for forming a decision about changing their actions, since all questions are rated above the mean. This fits with the results of other research, where, e.g., students had to decide about vaccination and were rather hesitant because they

wanted more information [58]. Hence, even if research has not yet been able to prove uniformly that knowledge influences decisions, the results of this study show that information is (subjectively) highly relevant for the people who make decisions. Furthermore, it could be shown that all three types of knowledge, as assumed in the model (Figure 2), are relevant. Accordingly, the results of this study support the model assumptions.

However, the study's results are limited to some extent. On the one hand, this concerns the sample, which does not permit generalization but yet gives valuable insight into how students value information for decision-making. On the other hand, the object of investigation is limited because we chose to examine the very close relationship between sugar consumption and type 2 diabetes. This limitation is, on the one hand, necessary to achieve sufficient depth of knowledge, because tests and questionnaires can only have a certain length, and one has to decide whether the topic is covered in depth or breadth. This, of course, means that other factors influencing the onset of type 2 diabetes, such as exercise and diet in general, as well as genetic factors, cannot be adequately assessed. On the other hand, this close connection also follows the law of specificity [34]. According to Fishbein and Ajzen [34], a lack of correlation between knowledge and action is due to a lack of fit between knowledge and the dependent variable [50]. Furthermore, only the significance of knowledge for the decision was inquired. This investigation cannot examine to what extent the knowledge influences the actual action. Additionally, this study takes a look at decision-making from a very individualistic point of view. For reasons of feasibility, it is assumed that the individual decision or action depends solely on the individual and his or her personal assessment. Social, political, and economic reasons are neglected for this purpose. It is assumed that people who decide to take action and notice that external limits are imposed on them are more willing to change such conditions [19,20].

5. Conclusions and Outlook

This study's results indicate that students want and need a solid understanding of all three knowledge types to form informed decisions. Accordingly, if teachers want to support students in making health-related decisions, they should include all three types of knowledge in their teaching. Accordingly, it is not enough to simply explain the causes of a disease (SK) or even to convey what health-promoting behaviour would be (AK). The data indicate that it makes sense to convey knowledge about the disease and its causes (SK) and possible alternative courses of action (AK), but also how effective different courses of action can ever be (EK). Using type 2 diabetes as an example, this would mean that both diabetes and its development would be discussed, and the role of sugar in this would be addressed (SK). In addition, ways of reducing sugar intake should be shown (AK), but also its effectiveness (possibly in connection with other behaviours) should be discussed (EK).

The next steps in research will be to gather data from a larger sample as well as for other health contexts in order to broaden the message. However, now that we have found hints that, consistent with the model, learners find the three types of knowledge relevant to their decisions, further research can be done in this direction: if these knowledge types are important, are they included in curricula and do students have knowledge in all three dimensions to the same extent and, if so, do they use it in decision-making processes? These are questions that we will ask in following studies. Yet despite all this, it becomes clear that although knowledge seems to be relevant, the respective knowledge for all possible health decisions can neither be learned nor taught. Therefore, the goal of the project is to shed light on the actual role of knowledge and, in a first step, the three dimensions in decision-making and intention formation. Then, implications for school science shall be formulated about how to prepare students to be able to adapt to different situations, e.g., by learning how to gather and reflect information and, thereby, to become responsible decision-makers. The question then is, how can science education equip people to be able to get the necessary information and use it? Or, in connection to the model in Figure 2, what is the scientific literacy underlying that specific knowledge? Here, four "tools" can be suggested [18]: (1) Systems Thinking, because the body can be seen as a system (and yet part of other systems), which can lead to complex interdependencies. Yet, if students have an

understanding of systems, they are more likely to understand the system and reflect on the borders of knowledge (e.g., [59–61]). This point leads to (2) knowledge and understanding of the Nature of Science. This is important to understand and appreciate, e.g., that scientific knowledge is tentative, provisional, and uncertain and can be influenced by values and bias (e.g., [61,62]). However, not only is science influenced by values, every person has values, and decisions cannot be purely objective, because (3) affectivity plays a role, and subjective judgments (e.g., [15]) and personal values must be taken into account for action decisions as suggested by many health behavior models (e.g., [24,32–43]), as summarized in [23]. Finally, one needs (4) critical thinking to be able to reflect one's point of view, question information critically, and be able to change perspectives (e.g., [63,64]).

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