Medical Students Cooperate With Patients and Communication Students to Design Audiovisual Patient Education

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Abstract

Having access to health information makes patients feel more empowered in making decisions about their healthcare. However, the reliability and applicability of online health information is difficult to assess. To give patients the tools to make decisions about their own care, doctors need to inform patients in and outside of the doctor's office. To teach future doctors the communication skills needed for this, we developed a new educational course called CLIKCS: Co-creating onLine Information Knowledge Clips for Society. During the course medical students designed knowledge clips in cooperation with patients and Communication and Information Sciences (CIS) students. The aim of this research was to evaluate how the course improved the science communication skills of medical students. Twelve sixth-year medical students, six patients and three third-year CIS students participated in this study. If and how medical students improved their communication skills was evaluated by analyzing the storyboards, assessing the knowledge clips and conducting interviews with the medical students. The knowledge clip assessment showed that the medical students succeeded in making suitable patient education materials and comparing the first and second draft of the storyboard showed that they improved their skills during the course. Finally, the interviews indicated that cooperating with the patient and to a lesser extent with the CIS student improved the science communication skills of the medical students by making them understand the experiences, perspective and information needs of the patients and by helping them become aware of how to convey medical information in an understandable way.

Keywords: Medical students, communication skills, patient participation, patient education

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Changes in the power balance between doctors and patients have caused a paradigm shift in medicine from doctor-centered care to patient-centered care (Jones, Higgs, De Angelis, & Prideaux, 2001; Vijn et al., 2017). Patient-centered care entails that medical professionals respect and respond to patients' needs and preferences, help patients obtain the information they need to participate in their care, give emotional support, and involve patients' family and friends (Institute of Medicine (US) Committee on Quality of Health Care in America, 2001). The shift in power balance is partially caused by the changes in the accessibility of medical information for the public (Hoving, Visser, Mullen, & van den Borne, 2010).

In this digital era, health information is more accessible than ever before. Patients often search for medical information online, even before seeing a doctor (Meppelink, van Weert, Brosius, & Smit, 2017; Morahan-Martin, 2004). Approximately 60% of adults in the United States use the internet to search for information about health issues (Fox, 2011). The advantage of online health information (OHI) is that it is accessible at any point in time and at a low cost. Additionally, because the internet is anonymous, patients feel safe to search for sensitive health information. For example, due to the stigma associated with mental health issues, it is difficult for patients to reach out to a professional. The first place to search for information about mental health is, therefore, often the internet. Patients who have access to OHI can feel more empowered and confident in making decisions about their health and treatment (Morahan-Martin, 2004).

Nevertheless, the reliability of OHI is difficult to assess, and the amount of information sources can be overwhelming for patients (Meppelink et al., 2017; Morahan-Martin, 2004). Patients need sufficient health literacy to understand OHI and judge its accuracy. Health literacy is defined by Berkman, Davis and McCormack (2010) as: "The degree to which individuals can obtain, process, understand, and communicate about health-related information needed to make informed health decisions" (p.16). Of the Dutch population, approximately 25% has inadequate health literacy and in other countries in Europe this percentage is even higher (Sørensen et al., 2013). Only when the

information is understood, will patients be able to make informed health decisions in cooperation with the doctor (Bol, van Weert, de Haes, Loos, & Smets, 2015). Medical information needs to be adjusted to the capabilities of all patients to be understood by them.

This research focusses on the skills doctors need to design patient education materials and to facilitate the process of patient participation. It is necessary for doctors to have science communication skills to cooperate with patients and to guide them in the decision-making process. They need to be able to educate and inform patients, while considering the perspective and potentially low health literacy of the patients (Hoving et al., 2010; Roper & Jorm, 2017).

Therefore, a new course called CLIKCS (Co-creating onLine Information Knowledge Clips for Society) was developed. During the course medical students design online patient education in cooperation with a patient and a student communication and information sciences (CIS). The cooperation gives the medical students the opportunity to learn from the unique perspectives the patient and CIS student have to offer. The purpose of this educational course is to teach medical students to communicate more effectively with their patients, and to make reliable and accessible patient education. The aim of this research is to evaluate how CLIKCS contributed to the development of the science communication skills of medical students, needed to educate patients about their medical situation.

Theoretical Background

Having medical students design patient education can be beneficial for both patients and students. It is beneficial for patients because providing simple and understandable information to patients helps to increase the participation of patients in health care decisions (Hoving et al., 2010). Additionally, information that is patient-centered has a positive impact on the patients' ability to manage chronic illnesses and adherence to the prescribed medical treatment (Levinson, Lesser, & Epstein, 2010).

Furthermore, having medical students design patient education can improve students' self-efficacy in all types of patient encounters. According to a review by Vijn et al., (2017) on patient education designed or presented by students: "enabling students to provide patient education was reported to enhance students' patient education skills, patient education self-efficacy, patient education behavior, relations with patients, and communication skills" (p. 1038). For example, a study by Hess and Whelan (2009) evaluated a pilot course where medical students had to give a plain language

presentation to adults with low health literacy. The medical students were paired with adults and were assigned a medical topic for their presentation that was of importance to the adults. After the presentation the adults gave the medical students feedback. The most important learning outcomes according to the medical students were that their understanding of the information needs of the patients was improved, as well as their awareness of the challenges of using plain language.

The aforementioned study illustrates that science communication is more than just replacing jargon with language that is understandable for the patients; students need to learn to take the perspective of the patient to determine what the patient wants and needs to know (Brownell, Price, & Steinman, 2013; Fischhoff, 2013; Levinson et al., 2010; Salita, 2015). It is, therefore, important to ask two questions when designing patient education materials: (1) what does my target audience need to know and (2) how do I convey this message?

What to Communicate?

To understand what a patient needs to know, a doctor needs to get to know the patient. It is important to consider the health literacy, prior knowledge and attitudes of the target audience to design patient education that succeeds in conveying the intended message (Mercer-Mapstone, 2014; Salita, 2015).

Purpose and outcome. Firstly, it is important to determine the purpose and intended outcome of the patient education. The content of the education can vary extremely depending on the purpose. Health information can, for example, have the purpose of informing patients about their illness, giving patients instructions about taking medicine, or convincing the public to participate in a disease-screening program. Accordingly, the intended outcome of OHI can be to comfort patients, to empower patients to use medicine in the correct manner, or to urge patients to act a certain way (Helitzer, Hollis, Cotner, & Oestreicher, 2009; Levinson et al., 2010; Mercer-Mapstone, 2014).

Prior knowledge. Secondly, to gain insight into what information is essential to include in OHI, it is necessary to assess the prior knowledge and health literacy of the target audience (Mercer-Mapstone, 2014). Only when OHI is understood and retained, it is possible to achieve the intended outcome (Bol et al., 2015). When learning something, the new information is often integrated with the learner's prior knowledge (Mayer, 2001). The prior knowledge of the target audience depends on the level of education,

health literacy, age, and experience (Mercer-Mapstone, 2014). Chronically ill patients, who have been sick for several years, most likely know considerably more about their disease than patients that have been diagnosed just recently. It is important to identify and understand the target audience to adjust the content of OHI to their needs. Only when the perspective and background of the target audience is explored, fitting OHI can be designed.

Something else to consider is that not all prior knowledge the target audience has, is necessarily correct. Patients may have misconceptions. A well-known and persistent misconception is that vaccinations can cause autism. Even though this notion is not correct (Plotkin, Gerber, & Offit, 2009), it can influence the attitude of the target audience and the way they perceive OHI about vaccinations. If this misconception is not addressed, the OHI will probably not have the intended effect (Fischhoff, 2013).

Perspective of the target audience. Lastly, the social, political, and cultural background of the target audience needs to be taken into consideration (Doak, Doak, & Root, 1996; Mercer-Mapstone, 2014). The same applies to the attitude of the patient towards the information. If the target audience has a negative attitude towards the information, the content or purpose needs to be adjusted to this. For example, before a patient can be convinced to take action, they need a positive attitude towards the given information (Salita, 2015). The cultural background of the target audience can influence the attitudes they have towards the information. It is therefore important to assess whether the target audience has, for example, strong religious or political believes (Mercer-Mapstone, 2014).

How to Communicate?

To ensure that OHI is effective, a balance between accessibility and accuracy needs to be found (Salita, 2015). The content needs to be as correct and informative as possible, while being comprehensible at the same time. To make OHI accessible to patients with different levels of health literacy, it is important to reduce the cognitive load of the material. Cognitive load is the capacity to process new information that leads to meaningful learning and retention. According to the Cognitive Theory of Multimedia Learning humans have a limited capacity for processing information (Mayer, 2001; Mayer & Moreno, 2003). Presenting too much information at once can cause an overload and lead to a decrease in comprehension and retention. Mayer (2001) discusses several ways to avoid cognitive

overload: (1) use images and text in combination to convey the message, (2) use images that match the text, (3) present images and corresponding text at the same time, (4) remove distracting additions, such as non-informative objects in images, and (5) replace written text with narration in an informal style.

A study by Meppelink, van Weert, Haven and Smit (2015) supports aforementioned principles. 231 participants were exposed to one of four messages about colorectal cancer screening: written text with illustrations, spoken text with illustrations, written text with animation, or spoken text with animation. A combination of spoken text and animation was found to be the best method to limit cognitive overload and improve recall in people with low health literacy. When exposed to this condition the group with low health literacy recalled the same amount of information as the high literacy group, whereas in all other conditions the high literate group recalled more. The condition with text and animation did not negatively affect the group with high health literacy and can therefore be used for groups with high and low health literacy.

In addition to the use of correct images, the text or narration needs to be easy to understand as well. If a complicated subject is discussed, it is important to limit the use of difficult words and complex sentence structures. Demanding words and sentences cause unnecessary processing and limit the capacity to process information (Oakland & Lane, 2004). Therefore, sentences need to be concise and simple, the structure of the text needs to be transparent, and all notions need to be relevant to the content of the text (Cutts, 2015; Mikk, 2000).

Furthermore, the use of jargon should be avoided. Whether a term is considered jargon or not can be difficult to identify (Brownell et al., 2013; Cutts, 2015; Salita, 2015). For example, the word *unconscious* is a frequently used word in medical science and is easy to understand for medical professionals. However, a study among 700 people visiting an accident and emergency department found that approximately a quarter of the participants was unable to give a correct answer to questions designed to test their understanding of the word *unconscious*. 16% of the participants believed one can still talk when unconscious, and 52% believed one is still able to hear after losing consciousness (Cooke, Wilson, Cox, & Roalfe, 2000).

Likewise, words with a different meaning in everyday life should be avoided (Brownell et al., 2013; Salita, 2015). These words can be even more confusing than jargon; jargon is easy to recognize,

familiar words with an alternate definition are not (Salita, 2015). Phrases such as *positive result* or *positive trend* could be misinterpreted by the lay audience. Positive is often interpreted as something good. However, as scientific term *positive result* indicates that the disease, condition, or biomarker for which the test is being done, has been found. The positive result of a test is not necessarily the good news the patient was hoping for (Cutts, 2015; Salita, 2015). Hence, the use of terms of which the scientific meaning does not align with the everyday meaning should be avoided to prevent confusion.

Project-Based Learning

To teach medical students both how to convey a message and to find out what the target audience wants to know, the setup of the CLIKCS course was based on project-based learning. Project-based learning is a teaching method in which students collaborate with peers or other professionals to create an end-product in response to an authentic question or problem (Barak & Dori, 2004; Krajcik & Blumenfeld, 2006). In the case of CLIKCS medical students cooperate with a patient and a CIS student. The medical students can use the knowledge and skills they gained from the cooperation to create an end-product.

Project-based learning has five key components: (1) a driving question that is the core of the project, (2) collaboration with other students, professionals, or members of the target audience, (3) a real-life context, (4) the use of cognitive tools, for example the internet, and (5) the production of artifacts (Barak & Dori, 2004; Thomas, 2000). These five essential components were included in the CLIKCS course as follows: The first component, the driving question, is provided by the patient. The driving question is based on a real question the patient has about their disease or medical care. By cooperating with a patient and using a genuine question, component 2 (collaboration) and component 3 (real-life context) are included. After the driving question is chosen, the medical students explore the topic using the internet and other sources (component 4: use of cognitive tool). Finally, the medical students create the artifacts (component 5) in the shape of two storyboards and, as end-product, an educational knowledge clip.

Project-based learning is built on multiple learning theories: active construction, situated learning, the use of cognitive tools, and social interaction (Krajcik & Blumenfeld, 2006).

Active construction. According to constructivism, knowledge is actively constructed through experiences and interaction with the environment. Developing knowledge, skills, and understanding is a constant process of integrating new experiences with prior knowledge (Savery & Duffy, 1995). In contrast to passively taking in information, knowledge is actively constructed during project-based learning. The participants explore the driving question, build their knowledge, discuss with others, and apply all they have learned to create an end-product (Krajcik & Blumenfeld, 2006).

Situated learning. During project-based learning it is important that a project takes place in a real-life situation (Krajcik & Blumenfeld, 2006; Thomas, 2000). This is essential for two reasons. First, when the problem or driving question is real, the answer or product is of actual importance to the community. The value of the project for the community motivates the participants to bring the project to a successful conclusion. Motivation of the students is particularly important in project-based learning, because the students are responsible for their own learning during the project (Brownell et al., 2013; Thomas, 2000). Second, the real-life context gives the students the opportunity to apply the knowledge and skills they learn to a meaningful and authentic context. They can now relate the acquired information to their prior knowledge and experiences and develop a more linked conceptual understanding of the things they learned. This makes it easier to apply their knowledge and skills in new contexts and to generalize them to answer a variety of questions (Krajcik & Blumenfeld, 2006).

The use of cognitive tools. Cognitive tools, such as the internet, graphs, or animation software, can be important in learning. They give students access to information, can show patterns in data, or help students in designing multimedia products that show their understanding. Moreover, the cognitive tools increase the quantity of experiences that students can have, and the amount of problems they can solve. During project-based learning students are assisted by the cognitive tools to facilitate their learning process (Krajcik & Blumenfeld, 2006).

Social interaction. Through social interaction it is possible to discuss, share, and receive knowledge with/from others. This helps to create a community of learners and gives students insight into perspectives of other participants. For the development of (patient) education it is essential to identify and understand the target audience. Through direct interaction with a member of the target audience, students can become aware of what is important to the target audience and what concepts

might be challenging for them to grasp (Brownell et al., 2013). Additionally, feedback form a lay person on the materials is useful to detect jargon and confusing language (Salita, 2015).

Besides from working with the target audience, working with other professionals can also be of great value. This is called interprofessional education (IPE). In IPE two or more groups of students of different professions learn with and from one another. Simply learning side by side (e.g. attending the same lecture) lacks the interactive element that IPE needs (Hammick, Freeth, Koppel, Reeves, & Barr, 2007). IPE is only effective when students actively interact with each other and collaborate to solve a problem or create something using their own expertise (Cooke et al., 2000). In this shared learning experience students can share knowledge and skills with other professionals and learn to perceive the task from the perspective of the other profession as well as from their own. When students communicate and collaborate they will gain insight into the perspective of other professionals and improve their collaboration skills (Hallin, Henriksson, Dalén, & Kiessling, 2011).

Research Question

To summarize, involving medical students in designing patient education can be a useful method to teach communication skills. To improve their science communication skills medical students need to learn *what* to communicate and *how* to communicate. CLIKCS, which is based on the teaching method project-based learning, aims to teach both. This research evaluates which aspects of CLIKCS contribute to the development of the science communication skills.

To evaluate this it is important to assess two things: do the medical students improve their science communication skills and which processes take place during the course that facilitate the improvement of the communication skills? Not all components of the course could be evaluated in this study, due to time constraints. Therefore, the research is focused on two important components of CLIKCS: the cooperation with the patient and the cooperation with the CIS student. This research aims to answer the following two research questions:

RQ1: Do the medical students improve their science communication skills during the course?

RQ2: How can the cooperation with the patient and the CIS student improve the science communication skills of the medical students?

Methods

The research questions were answered using three methods. The first research question (RQ1) was answered using assessment of the knowledge clips and analysis of the storyboards. The second research question (RQ2) was answered using semi-structured interviews. Ethical approval of this study was provided by the Dutch Association for Medical Education (NVMO, NERB file number: 2019.1.4).

Participants

The participants were selected using convenience sampling. In the CLIKCS course twelve medical students, three CIS students and six patients participated. All students were enrolled at Utrecht University. The medical students were in their sixth year of medical education and CIS students were in their third year of their bachelor education. The patients were recruited through the patient organization Stichting Hartekind. The participants were either born with a heart defect or the parents of a child with a congenital heart defect. For the sake of clarity, both patients and parents will be referred to as patients in the rest of this paper.

Sixth year medical students were chosen as the target group, because they are in the concluding phase of their medical education and are in contact with patients already (Vijn et al., 2017). Because the students are in their concluding phase, they can individually interact with patients and are confident and independent enough to do this successfully. Additionally, because they already have been in contact with patients during their residency, they recognize the importance of learning how to convey medical information to patients and empathizing with their situation. Only the medical students were subjects of the research: only the artifacts created by the medical students – the storyboards and the knowledge clip – were studied and only the medical students were interviewed. Informed written consent was obtained from each student prior to enrolment in the study.

Intervention

The participants took part in the CLIKCS course from February to April 2019 (6 weeks). The design of the course is displayed in Figure 1. At the start the participants were divided into groups consisting of two medical students, one patient and one CIS student.

Role of the medical students. During the course the medical students had to attend one lecture, go to three meetings, write two storyboards, create a knowledge clip and give one presentation. To create

the knowledge clips the medical students used the software of their choice, for example Vyond, iMovie, or Videoscribe. If they ran into problems during the creation of the knowledge clip, they could consult the patient, the CIS student, or a digital tools specialist. With questions about the medical content, they could consult a pediatrician, who also checked the accuracy of the medical information presented in the clip.

Role of the patients. During the course the patients cooperated with one duo of medical students. They met the students two times. The first time to get acquainted and propose a driving question and the second time to give feedback on the first version of the storyboard. They were also invited to attend the final presentations. The task of the patients was to share their experiences and tell the students what information they had missed about their or their child's disease.

Role of the CIS students. Each CIS student cooperated with two groups of medical students. During the introduction the CIS students gave a mini-lecture about how to effectively convey information in a knowledge clip. Additionally, they had two meetings with each group. During the first meeting they helped the medical students to determine the purpose of their knowledge clip and get more insight into the characteristics of the target audience. During the second meeting, with both the medical students and the patient, they gave feedback on the first draft of the storyboard. They were given the task to give the students advice based on their own expertise as a communication professional. After the medical students improved the storyboard, the CIS students presented the second draft to members of the target audience. Based on the results of this small research they wrote an advice report for the medical students.

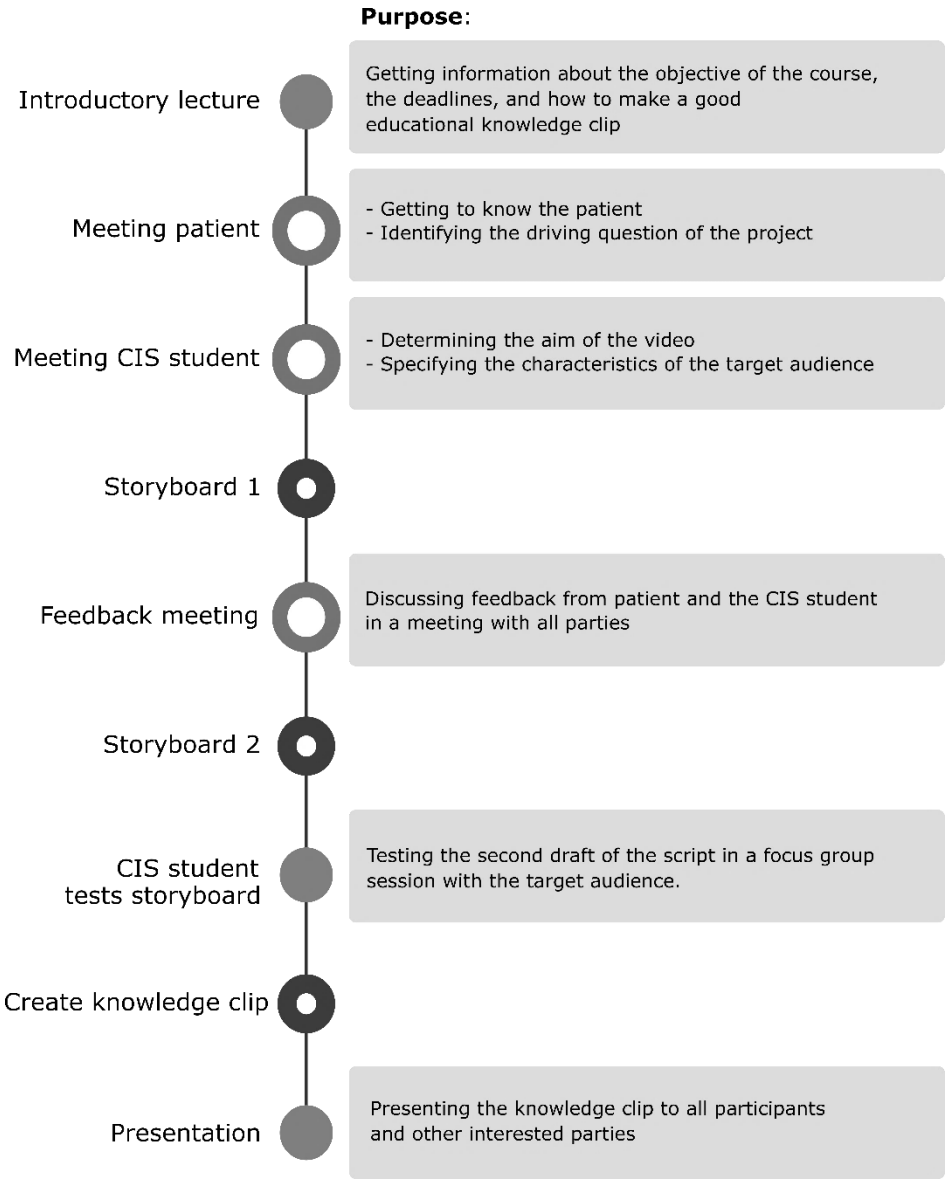

Figure 1. Design of the CLIKCS course. This overview shows which elements are part of the course and the purpose of the elements.

Research Instruments

To answer the research questions three methods are used. Semi-structured interviews address the important issues, while also giving the participants the opportunity to use their own words and form their own thoughts. This method is very suitable to gain insight into the feelings, experiences, and opinions of participants (Denscombe, 2010). However, the account of participants is subjective. This raises the question: Is the self-reported improvement achieved?

Therefore, this research aimed to answer two research questions. The fist research question (RQ1) was answered using the analysis of the storyboards and the assessment of the knowledge clip.

Through the assessment of the knowledge clip created by the medical students was evaluated whether the participants put the things they learned during the course into practice. Through the analysis of the storyboards was evaluated whether the students improved during the course.

The second research question (RQ2) was answered using the interviews. To concretize which parts of CLIKCS lead to which outcomes a conjecture map was constructed (Sandoval, 2014). The conjecture map shows the parts of the course (*embodiment*) that are conjectured to generate *mediating processes* that lead to *desired outcomes* (Figure 2). Mediating processes are activities or interactions that support learning and are hypothesized to lead to certain outcomes (Sandoval, 2014). The outcomes presented in the conjecture map are based on the two components of science communication skills discussed in the theoretical background: knowing *what* to communicate and knowing *how* to communicate.

The high-level conjecture for this study is: “By cooperating with patients and CIS students to create educational knowledge clips, medical students’ science communication skills improve. Cooperation with a patient and a CIS student is conjectured to lead to the depicted mediating processes and outcomes.” Whether these mediating processes were, in fact, generated by the embodiment was evaluated using the results of the interviews. Whether the mediating processes lead to the desired outcomes is evaluated using the knowledge clip assessment and storyboard analysis.

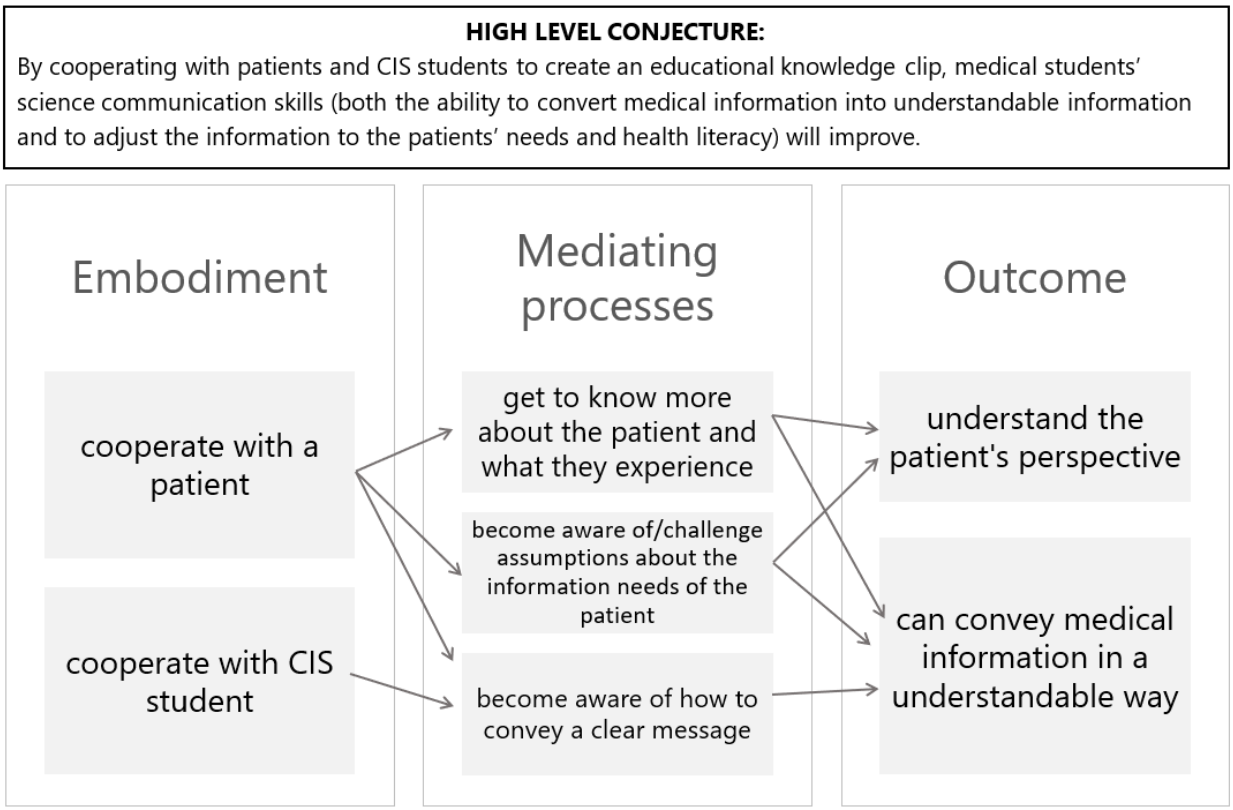

Figure 2. Conjecture map showing which parts of the embodiment of CLIKCS are assumed to lead to which mediating processes and outcomes.

Data Collection and Analysis

Knowledge clip assessment. The knowledge clips created during the course were assessed using the Suitability Assessment of Materials (SAM), created by Doak et al. (1996). SAM is a validated assessment tool to assess the suitability of online patient education, and is used in numerous other studies (Bui, Silva-Hirschberg, Torres, & Armstrong, 2018; Helitzer et al., 2009; Meppelink et al., 2017; Rhee, Von Feldt, Schumacher, & Merkel, 2013; Ryan et al., 2014). It is originally developed to assess written health information but has also been successfully used to assess video and audio materials (Doak et al., 1996).

The assessment is based on the rating of 22 factors. The 22 factors were rated as 0 (not suitable), 1 (adequate), or 2 (superior). Not applicable (N.A.) was also used, because not every item was applicable to each knowledge clip. The total score was divided by the number of factors rated – if a factor does not apply, 2 points were extracted of the possible 44 points – which results in a percentage score. Materials with a score between 0–39% are labeled as not suitable, between 40–69% as adequate, and between 70–

100% as superior. For this research three factors were deemed not applicable to all knowledge clips, because these factors only applied to written text. An overview of all remaining factors and an explanation of what each factor represents, is presented in Table 1.

A second assessor independently scored two randomly selected knowledge clips and the scores were compared with the scores of the first assessor to assess the inter-rater reliability. The assessors agreed on 33 of the total 38 items, with a Cohen's kappa of .74, which suggests a good inter-rater reliability (Cicchetti, 1994). Therefore, no alterations had to be made to this method and the scores of the first assessor were used as the final results.

In addition to the assessment with the SAM, the knowledge clips were graded by six teachers. All teachers were members of the CLIKCS project team. Each knowledge clip was graded by two teachers on a scale from 1–10. The two grades were combined to produce a final grade.

Table 1

Factors of the Suitability Assessment of Materials

Factor	Explanation
Purpose	Make the purpose of the materials clear, to avoid that the audience misses main points.
Scope	Scope is limited to purpose and to what the audience can realistically learn in the given time.
Summary & review	Review the main points in other words or images to increase comprehension and to avoid that the audience misses the main points.
Writing style	Use conversational style and active voice. Long sentences and the passive voice decrease comprehension.
Sentence construction	Give context before offering new information to increase comprehension.
Vocabulary	Use common and imagery words. Avoid general terms, technical terms and value judgments.
Advance organizers	Use statements to tell what comes next and to add structure to the information to make sure that the audience can follow along.
Graphics	Use images that are friendly, attract attention and match the purpose of the material.
Type of illustrations	Use simple drawings and drawings that are familiar and easily recognized by the audience.
Relevance of illustrations	Eliminate all nonessential details such as backgrounds, unnecessary objects and unneeded color. The illustration should present only the key points of the story.
Graphics: lists, tables, charts, forms	Explain and guide the audience through the lists and charts used in the material. Do not use any unnecessary graphics.
Layout	Make the layout consistent, attractive, simple and related to the text.

Factor	Explanation
Typography	Use appropriate fonts and font sizes. Do not use all caps. To clarify structure and attract attention use typographic cues, such as color, size and bold type.
Subheadings and "chunking"	Make lists of no more than 5 independent items to avoid information overload. Use appropriate headings for the lists.
Interaction included in text and/or graphics	Ask the audience to solve problems, make choices, and answer questions to involve the audience and enhance retention.
Desired behavior patterns are modeled	Use specific and familiar examples/concepts to make sure that the audience recognizes the concepts and can apply them to their own situation.
Motivation	Divide complicated concepts into small steps to let the audience experience small successes in understanding the information, increasing their self-confidence and motivation to learn.
Cultural match – logic, language, experience (LLE)	Match the logic, language and experiences used in the material to the LLE of the target audience. Ensure that the central concepts match the perspective of the audience.
Cultural image and examples	Present cultural images and examples in realistic, representative and positive ways.

Analysis of storyboards. The medical students created two storyboards during the course: a first draft of the storyboard and a second draft of the storyboard. To assess the students' progress throughout the course, the two storyboards were compared, and all differences were highlighted. For all highlighted differences, two researchers assessed which version was superior and why. During this process the researchers were unaware which of the storyboards was the first and which was the second draft. To assess why one version was better than the other, the factors presented in the Suitability Assessment of Materials were used as a guideline. *Content* was added as extra factor, because this factor was not present in the SAM, but was often a reason why one version was superior over the other. The factor *Content* was described as follows: *a content improvement to the storyboard, that is more suitable, more accurate, or is appropriate information to add*. It was possible to assign more than one factor to one difference.

The inter-rater reliability between the two researchers was assessed using Cohen's kappa. Which version of the storyboard the researcher rated as superior for every difference was compared. This resulted in an agreement of 57 out of 71 differences ($\kappa = .683$), which suggests a good inter-rater reliability (Cicchetti, 1994). However, the reasons why one version was superior was more difficult to

compare, because multiple reasons could be chosen. Therefore, the two researchers discussed all items and a consensus was reached for all discrepancies.

Interviews. In addition to abovementioned methods, semi-structured interviews were employed. All medical students and patients were interviewed individually. The interviews were conducted by two interviewers. During the first two interviews both interviewers were present to align their interview styles and to make sure the rest of the interviews were conducted in a similar fashion. The rest of the interviews were divided between the two interviewers. The interviews were audio recorded and transcribed verbatim. Afterwards, the transcripts were analyzed in cycles: open, axial, and finally selective coding (Boeije, 2009). Two of the twelve interviews were independently coded by a second coder and the inter-rater reliability was assessed using Cohen's kappa. Out of 34 segments, 30 were coded identically by the two researchers ($\kappa = .872$), which suggests an excellent inter-rated reliability (Cicchetti, 1994). Therefore, only the coding results of the first researcher were used.

Results

Knowledge Clip Assessment

Suitability assessment of materials. All of the six knowledge clips were rated as superior with scores ranging from 71% to 89%. The factors that overall scored highest were Purpose, Writing style, Motivation, and Cultural match in logic, language and experience. The knowledge clips scored lowest on the factors Summary and Interaction. See Table 1 for an explanation of what each factor represents.

Grades. All knowledge clips received passing grades from the teachers of the course ranging from 6.8 to 8.8 on a scale from 1–10. This corresponds with the SAM scores. The knowledge clips that received relatively low grades also received low SAM scores and vice versa. See Table 2 for an overview of all grades and SAM scores.

Table 2

Overview of Scores Knowledge Clips

Knowledge clip	SAM score (in %)	Grade (on a scale from 1–10)
1. Life with an ICD	87%	8.0
2. Truncus arteriosus: what is it?	89%	8.0
3. Endocarditis	71%	6.8
4. Pulmonary atresia	83%	8.0
5. Truncus arteriosus: birth and operation	74%	7.0
6. Which healthcare professionals?	89%	8.8

Storyboard Analysis

The first and second draft of the storyboards of five groups were compared. The storyboards of the sixth group could not be compared, because this group changed the subject between the first and second draft of the storyboard. In total 67 differences were found. For 50 of the differences (75%) the second draft of the script was scored as superior. For 15 differences (22%) the first draft was scored as superior and for 2 differences (3%) the researches were unable to select a superior version. For each group the second draft was superior for the majority of the differences between the storyboards.

The factors that were overall most often improved were Cultural match in logic, language and experience (13x), Content (10x), Vocabulary (8x), Scope (8x), Advance organizers (5x), and Writing style (5x). The factors that were most often better in the first draft were Vocabulary (5x), Scope (4x), and Cultural match in logic, language and experience (3x). In Table 3 some examples are given of the differences between the storyboards. For all shown examples the second draft was superior to the first. The factor that is improved and the reason why are also displayed.

Table 3
Examples of Improvements to the Second Draft of the Storyboard

First draft storyboard	Second draft storyboard	Factor	Explanation
By showing your ICD pass, you can request to be searched immediately.	If you get nervous about walking through the metal detector, you can request to be searched immediately by showing your ICD pass.	Cultural match in LLE	The second addresses possible feelings the patient can have.
This can have serious consequences.	The body has found a smart solution for this.	Cultural match in LLE	The second is less disturbing for the audience.
Immediately after birth it notices the effect of this oxygen deficiency. It breathes quickly and with difficulty and has no energy to drink.	This can be seen immediately after birth; your child breathes quickly and with difficulty and has no energy to drink.	Cultural match in LLE / Vocabulary	Using ‘it’ to refer to a child is not suitable / ‘Oxygen deficiency’ is a difficult medical term.
This is possible via two routes. A gap between the two atria, the foramen ovale, and a vessel between the aorta and pulmonary artery, the ductus arteriosus.	This is possible via two routes. The first route is a gap between the two atria, the foramen ovale. The second route is a vessel between the aorta and pulmonary artery, the ductus.	Advance organizers	Using the terms ‘the first route’ and ‘the second route’ adds structure and makes it easier to follow.

First draft storyboard	Second draft storyboard	Factor	Explanation
Having sex is also possible with an ICD.	You can have sex with an ICD.	Writing style	Active sentence is easier and more personal than the passive sentence.

Note: LLE = logic, language and experience

Interviews

For the analysis of the interviews the mediating processes described in the conjecture map (Figure 2) acted as a guideline to assess whether the cooperation with the patient and the cooperation with the CIS student produced these processes.

Cooperation with the patient. During the course the students had two meetings with the patients. Analysis of the interviews indicated that the students got to know the patients on a personal level during these meetings. The students characterized the relationship with the patient as an equal partnership and stated that it was different than a normal patient-doctor relationship. In the interviews the students were able to describe the experiences of the patients and reported that they had gotten to know a lot about the situation of the patient and the struggles they faced. They were able to see things from the perspective of the patient and relate to how difficult it is to have a disease. These results suggest that the mediating process *get to know more about the patient and what they experience* took place as a result of the conversations with the patient. In Table 4 several quotes from the interviews are presented, to illustrate aforementioned results.

Furthermore, the students were able to describe the information needs of the patient. Multiple students stated that what patients wanted to know was often different than they had expected and that the cooperation with the patients triggered this realization. The students first tendency was to make a knowledge clip explaining a medical process, but the patients wanted to know more about practical aspects of their disease or the hospital. For example: which doctors are involved, how does a feeding tube work, and what does the operating room look like? The students had to adjust their assumptions and became aware of the real information needs of the patients. This corresponds with the mediating process: *Become aware of /challenge assumptions about the information needs of the patients.* See Table 4 for the representative quotes that exemplify this.

Finally, the interviews show that the patients helped the medical students to improve their storyboards and ultimately their knowledge clip. The students reported that the feedback of the patients helped them to improve the vocabulary, structure and content of the video. Additionally, the patients were helpful in making the videos more compassionate. The feedback of the patient made the students aware that certain words and pictures, such as the word life expectancy or a picture of a baby with blue lips and extremities, can be shocking or uncomfortable for the patients. This suggests that the students *became more aware of how to convey a clear message*, the third mediating process (see Table 4 for representative quotes).

Table 4

Mediating Processes that Took Place as a Result of the Cooperation with the Patient Illustrated by Representative Quotes

Mediating process	Representative quote
1. Get to know more about the patient and what they experience	
a. Get to know more about the patient	"She gave a lot of feedback based on her own situation. For example, she needed medical care at home for her child. It was difficult for her to find out how to use a feeding tube. She wanted to have more information about how to do that and who she could ask for help." (Student 1)
b. Relate to what they experience	"I think I might be able to empathize a little better with the home situation of the patient and the parents. That it also has an effect on the people surrounding them and that the parents sometimes quite struggle with how to tell the family." (Student 2)
	"Now you can better imagine how though it is to have a disease. You don't often think about how confusing it is for patients to walk into a hospital and to try to find the outpatient clinic." (Student 3)
2. Become aware of /challenge assumptions about the information needs of the patients	
a. Become aware of information needs	"What really needs to be in the knowledge clip and what the patient really wants to hear became clear because of the conversation with the patient." (Student 2)
b. Challenge assumptions about information needs	"I would never come up with a video about how many doctors you will encounter. I'd more likely make a video explaining the disease. That was an eye-opener." (Student 4)
	"Things that seem obvious to me, can be a complete new world for the patient. I am in the hospital so often it feels like a second home. For others, the hospital is a very strange

Mediating process	Representative quote
	environment, where the smallest uncertainties can be very intense. This realization is important to have. I did, to some extent, realize that through the contact with [name patient].” (Student 1)
3. Become aware of how to convey a clear message	“What is normal for us, is not normal for others. Words that you use that you think are known to everyone. Such as ‘Prognosis’. When you ask a friend, you get a completely different explanation. You become aware of that it can mean different things. So becoming aware of the language used by us, that was really an eye opener for me. You know, but it is still confronting. You become aware of, oh yes, we really have to be clearer.” (Student 5)
	“The pictures we used. We first wanted to use a baby with blue lips and blue fingers, to show that they can have that. And then [name patient] said: no, don't do that, because you don't want to see that when you are pregnant.” (Student 6)
	“If we had made the made the video ourselves, it would have been decent. But in the end, it became a warm and compassionate video because of the input of the patient.” (Student 1)

Note: The mediating processes mentioned in the conjecture map are divided into subprocesses to give a more detailed explanation of how these processes took place.

Cooperation with the CIS student. The medical students went to two meetings with the CIS students and received feedback on the first draft of their script. Some medical students reported that the feedback they received from the CIS student helped them to improve the vocabulary and structure of the knowledge clip. The students described that the CIS students predominantly helped with language related issues, such as use of jargon, sentence structure and consistency. Several medical students stated that the CIS students knew very well how to convey a message and gave advice about how to do this. This suggests that the mediating process *become aware of how to convey a clear message* took place as a result of the cooperation with the CIS student. See Table 5 for some representative quotes from the interviews that exemplify this.

A mediating process that was not expected to take place as a result of the cooperation with the CIS student was *become aware of /challenge assumptions about the information needs of the patients*. However, the medical students stated during the interviews that the non-medical view that the CIS students had, was helpful to understand the perspective and information need of the audience better. The

CIS students helped them to understand which concepts are difficult for patients to grasp, what can be perceived as inhumane, and what information is unnecessary (see Table 5 for illustrative quotes).

On the other hand, several students reported that they did not see the added value of the cooperation with the CIS students. They stated that the patient had significantly more influence on the knowledge clip and thought that the time investment the CIS students had made was not in proportion with the value they added.

> I: Do you think the knowledge clip changed as a result of the feedback of the CIS student?
>
> S5: I think only minimal. We predominantly listened to [name patient]. (Student 7)

> In retrospect, I have benefited more from the cooperation with patient than from the communication student. We get quite a lot of communication education during our studies. Her points didn't have much added value for me and I think it took a lot of time for her. I don't know if her time investment really paid off. (Student 8)

These comments are not limited to one CIS student: All three CIS students cooperated with at least one medical student that had doubts about their added value. In total seven medical students expressed these feelings. Remarkably, only two of these medical students formed a pair. Of the other groups, only one of the two reported this.

Table 5

Mediating Processes That Took Place as a Result of the Cooperation With the CIS Student Illustrated by Representative Quotes

Mediating process	Representative quote
2. Become aware of /challenge assumptions about the information needs of the patients	Interviewer: "Did you have new insights from [name CIS student]'s feedback?" S7: "For parents, some images can be scary. A child on the intensive care could be scary. We do not intend to scare them." (Student 8) "Her expertise was mainly that she has zero medical knowledge. As a result, you empathize with patients who do not yet have [medical expertise]. That helped. As a medical student you quickly assume that something makes sense, while it does not make sense at all." (Student 4)
3. Become aware of how to convey a clear message	"In any case, the order, because that was something that [name CIS student] and [name patient] both had given feedback on. We did not know very well how to change this. So then we

Mediating process	Representative quote
	asked, okay, can you tell us what a logical order is? So they both gave us some ideas about that." (Student 6)
	"She did a target audience research with the storyboard and as a result we adjusted some textual things. We simplified some words. For example we changed anesthesiologist into sleep doctor. Things like that. Some of the jargon you assume is known, but this is of course not always the case." (Student 9)

Conclusion and Discussion

The aim of this research was to evaluate how CLIKCS contributes to the development of the science communication skills of medical students. This was evaluated using three methods: knowledge clip assessment, analysis of the storyboards and interviews with the medical students.

Research Question 1

The knowledge clip assessment indicated that all students succeeded in making a knowledge clip of sufficient quality. All knowledge clips received 'superior' SAM scores and passing grades from the teachers of CLIKCS. Additionally, the analysis of the storyboards showed that for each individual group the second draft of the storyboard was superior for the majority of the differences found between the first and second draft. This suggests that the medical students improved their science communication skills during the course (RQ1).

In the theoretical background science communication skills were divided into two components: knowing *what* to communicate and knowing *how* to communicate. These components correspond to the desired outcomes presented in the conjecture map (Figure 2): when students understand the patient's perspective, they know better *what* to communicate and when they can convey medical information in an understandable way, they know better *how* to communicate. The factors that were most often improved in the storyboard analysis were Cultural match in LLE, Content, Scope, Vocabulary, Writing style, and Advance organizers. The first three factors show that the students often knew better *what* to communicate in the second draft of the storyboard. They better matched the information to the perspective of the patient (Cultural match in LLE) and adjusted the information to what was important for the patient know (Content and Scope). The last three factors show that the students also knew better *how* to communicate in the second draft of the storyboard. They used more appropriate language

(Vocabulary), easier sentences (Writing style) and more words to indicate the structure of the knowledge clip (Advance organizers). This partly matches the factors of the SAM that scored overall highest in the knowledge clip assessment. All knowledge clips received the maximum score for the factors Cultural match in LLE and Writing style. The factors Vocabulary and Advance organizers could be improved even further in several knowledge clips.

To relate this back to the conjecture map, from the knowledge clip assessment can be concluded that the outcomes, *understand patient's perspective* and *can convey medical information in an understandable way*, are achieved. From the analysis of the storyboards can be concluded that the students improved these skills during the course.

Research question 2

The analysis of the interviews suggests that the mediating processes described in the conjecture map (Figure 2) took place and resulted from the cooperation with the patient and to a certain extent the cooperation with the CIS students. According to the students, the meetings with the patients gave a good insight into the experiences and the perspective of the patients (mediating process 1). The medical students adjusted their assumptions about what patients wanted to know and became more aware of the real information needs of the patients (mediating process 2). The feedback of both the patient and CIS student helped the medical students to better convey the message in the knowledge clip (mediating process 3). Additionally, the non-medical view of the CIS students helped several students to better understand the information need of the patients (mediating process 3). In Figure 3 the concept map is adjusted to accurately portray the processes that were linked to the cooperation with the CIS students. However, several medical students reported that the input of the patients was much more valuable than the input of the CIS students.

To answer RQ2: The cooperation with the patient and to a lesser extent the cooperation with the CIS student improved the science communication skills of the medical students by making them understand the experiences, perspective and information needs of the patients and by helping them become aware of how to convey medical information in an understandable way through feedback on the storyboards.

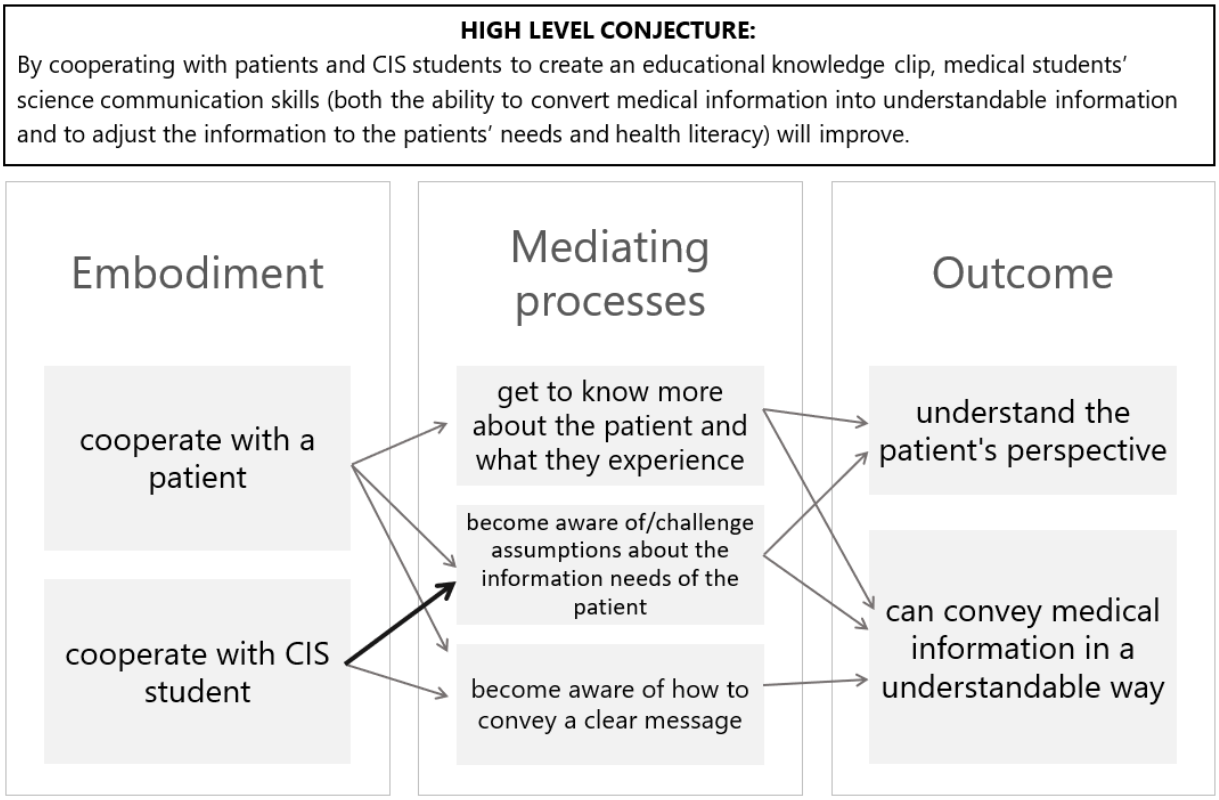

Figure 3. Adjusted conjecture map based on results of this research. One arrow was added, shown in black, to indicate that the results of the interviews suggested that the cooperation with the CIS student produced the indicated mediating process.

Limitations and Further Research

The cooperation with the CIS students was not seen as valuable as the cooperation with the patient by the medical students. Remarkably, often only one of the two medical students that formed a pair reported this. This suggests that it does not depend on the CIS student, but the expectations of the medical student. A possible explanation of the divergent opinions of the medical students is that they had different expectations of what the added value of the CIS student was supposed to be. Some students had expected the CIS student to know more about the technical aspect of using software programs to create the knowledge clip. This was however not the case. Another explanation could be that the medical students have had education about communication during their education before. It is possible that the medical students did not see the added value of the CIS students, because they presumed that they had the same level of expertise as the CIS student. In future renditions of this course it is therefore important to manage the student expectations better and prepare them for the difficulties of interprofessional

education. To find out what the real reason behind this is, it would be interesting to further investigate the cooperation between the medical students and the CIS students, by observing their interactions and interviewing both the medical and the CIS students.

The cooperation with the patient and the cooperation with the CIS students are just two of the aspects of the education that could improve the science communication skills. Other aspects, including but not limited to creating the knowledge clip, writing two storyboards, and cooperating with another medical student, could have contributed to the improvement of the communication skills. To get a more complete picture of how these and other components contributed, further research has to be conducted.

Other aspects that are not studied in this research are the applicability of the science communication skills in practice and the long-term retention of these skills. These could both be a subject of future study. It would be interesting to learn if the students remember what they learned over an extended period of time and whether they are inclined to use it in practice.

Finally, the success of CLIKCS was partly due to the highly motivated students that participated in the course. If the course is implemented in the curriculum, less motivated students will also be required to participate. Whether the results of this study can be replicated with less motivated students remains to be seen and needs to be studied in the future.

Take Home Message

Even though, the medical students received a great deal of communication education during six years of medical training, they were able to further improve their skills during this course. During CLIKCS the students put into practice the science communication skills they had learned to answer a real question and create a shareable product. Cooperating with a patient and CIS student gave them the opportunity to look at medical information from a different perspective. Having practiced this, the medical students are better prepared to effectively inform patients in and outside of the doctor’s office in patient-centered way.

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