

The Core Curriculum in Cariology: Fiction or Reality? Challenges about Implementation

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Keywords

Cariology · Undergraduate curriculum · Dental education · Dental caries

Abstract

Introduction: The Core Curriculum in Cariology (CCC) was developed by ORCA and ADEE in 2010. This article summarizes challenges for the implementation of the CCC at university/country level identified at the “Education Platform” of the ORCA 2022 conference in Cagliari, Sardinia. **Methods:** Participants from universities from 3 European (Italy, Poland, and UK), 2 Asian (India and Russia), and 3 American countries (Brazil, Colombia, and USA) led the presentations, discussion, and generation of statements. Presentations were transcribed and summarized through

qualitative content analysis. Key themes were identified, transformed into key topics, and sent to the panel for agreement. **Results:** Regardless of the wide variety of dental schools per country, from few (Poland $n = 10$) to many (India $n = 318$, Brazil $n = 563$) or from country/continent itself, frequent challenges to CCC implementation were highlighted. These included lack of agreement on a basic CCC as standard (96%), insufficient support or reimbursement for caries prevention and management (90%), separation between cariology and restorative dentistry (68%), focus on restorative/surgical management with prevention and nonoperative management being disconnected (73%). The group agreed that the integration of cariology and restorative dentistry remains essential to enhancing evidence-based decision-making, resulting in a shift of emphasis from cure to care. **Conclusion:** There is variation in the level of

implementation of the CCC. A frequent challenge is the disconnect between cariology and restorative dentistry. The CCC should be disseminated and promoted as a uniform blueprint/framework to facilitate the implementation of a common cariology curriculum among universities within each country, as well as internationally.

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Introduction

Teaching cariology requires a structured general evidence-based educational framework, which should be applicable or, if necessary, adaptable, on a global level. Hence, the European Organization for Caries Research (ORCA) together with the Association for Dental Education in Europe (ADEE) worked collaboratively to develop a standardized, evidence-based Core Curriculum in Cariology (CCC) starting in 2010 [1]. The core meeting of the CCC working group took place in Berlin/Germany in 2010 as a joint ORCA and ADEE workshop. The meeting was attended by 75 invited participants from 24 European countries and three countries from North and South America working in five breakout groups. Each working group outlined a different area of cariology education for dental students to create a consensus on five curriculum “domains”: knowledge base; risk assessment, diagnosis and synthesis; decision-making and preventive non-surgical therapy; decision-making and surgical therapy; and evidence-based cariology in clinical and public health practice. The final curriculum documents were reviewed and published by the chairs of the five working groups in five open-access papers, one for each domain [2–6].

In a global context, the development of the CCC was in line with the trend for standardization in teaching cariology and the development of national curricula and education standards in the field. The International Caries Detection and Assessment System (ICDAS) Foundation was also advancing to create a caries management tool, the “International Caries Classification and Management System” [7]. Once the CCC was published, successively in various countries academics have reviewed the original document and discussed modifications according to their different contexts (Colombia [8], Chile [9], the Caribbean [10], the USA [11], Canada [12], and Spain [13]).

The work being undertaken in this area has so far focused on agreeing on/modifying the CCC, as opposed to seeking to reinvent a new cariology curriculum. For the year 2022, ORCA and the ORCA-Education Platform (ORCA-EP) decided to focus its annual meeting on

challenges for the implementation of the CCC. This paper analyzes the statement: “The Core Curriculum in Cariology: Fiction or Reality?” discussed on the ORCA-EP in the frame of the ORCA conference 2022 in Cagliari, Sardinia, in preparation for a future update of the CCC. The aim of the meeting was to highlight existing challenges for the implementation of the CCC at the university/country level. Based on this meeting, this paper reports the consensus of participants’ statements, and it outlines participants’ challenges of implementation of the CCC at the university level for dental students.

Methods

After the agreement on the need for this meeting, a planning process considered the following aspects:

- Aim: To highlight existing challenges for the implementation of the CCC at the participant university/country level.
- Unit of analysis: To identify who can best answer the questions posed in the aim, an electronic PubMed search was conducted. The publication search date started in 2011 when the CCC was presented [1]. The subject index search included the following terms: “European core curriculum in cariology,” “cariology curricula,” “undergraduate dental students,” “consensus on cariology teaching for undergraduate dental students.” One researcher (R.M.S) conducted the search, and the findings were discussed with other two researchers (M.F. and C.H.S.). This resulted in a list of potential candidates to be invited. Potential participants without publications were identified through data collected from participation in past meetings of the ORCA’s “Education Platform.”

Participants were selected and invited by the ORCA education committee board (R.M.S., M.F., C.H.S.) aiming for representation from diverse countries where the CCC has been discussed or implemented. Representatives from 3 European countries (Italy, Poland, and the UK), 2 from Asia (India and Russia), 2 from Latin America (Brazil and Colombia), and the USA (Michigan and Iowa) were contacted to participate in the meeting and were also included as co-authors of the present paper. Participants were asked in their presentations not to limit themselves only to the views of their respective institutions, but rather to also broadly share when appropriate, based on their opinions or existing data, the national view on the CCC implementation of their country. Then, they agreed to deliver a comprehensive presentation highlighting the existing challenges in the implementation of the CCC at the university/country level.

- Data collection method: Considering the possible limitations per se of this meeting (first face-to-face meeting after the COVID-19 restrictions was lifted in many parts of the world), it was decided that the participants would make individual oral presentations and no initial group work was planned. Data were collected by taking notes (R.M.S. and C.H.S.) during the presentations and discussion. In addition, the original PowerPoint data were reviewed for any missing points. After the meeting, each of the researchers transcribed the information staying as close as possible to participants’ actual words.

- Team-based data synthesis: Each of the researchers responsible for transcribing the information identified concepts and patterns and created pre-categories. The 2 researchers who did this then met and combined the information and performed together the final categorization process, identifying common themes and categories, including subtopics. These were then sent to participants for agreement.

For each key topic, the percentage of agreement was calculated by dividing 100% by the number of statements in each key topic. Thus, if the key topic had 4 statements, each statement accounted for 25%, then when participants agree with all the statements, the total agreement is 100%. In the case of partial agreement on one of the statements, they are given half of the percentage of that statement (12.5%), bringing the total agreement to 87.5%, and so on. The included six key topics were the following:

- Agreement on the need to implement a standard CCC.
- Teaching cariology and separation between cariology and restorative dentistry.
- Focus on restorative/surgical caries management with prevention/control caries management “disconnected.”
- Lack of available eLearning for implementing the CCC.
- Need for caries diagnosis calibration and training in dental schools.
- Insufficient policy support and reimbursement for use of CCC concepts based on modern caries management.

The resulting statements were summarized in the table shown in the Result section and presented descriptively.

Results

Remarkably, most of the participants stated their countries have a national curriculum in dentistry or cariology, which is mostly non-compulsory, except for Poland, India, and Russia (Table 1). Regardless of the great variety in number of dental schools per country, from a few universities (Poland $n = 10$) to a larger number of dental schools (India $n = 318$, Brazil $n = 563$) or the country/continent itself, it appears that there is certainly considerable interest in increasing standardized dental education in cariology, with similar challenges. Challenges to the full implementation of the CCC are presented as general statements and subthemes. The total agreement of the statements is presented in Table 1.

The need to implement a standard CCC:

- There is considerable interest in improving cariology teaching for dental students in my setting (country or university); agreement: 96.8%.
- Getting all universities in my country to agree in a CCC is/remains very challenging; agreement: 93.7%.
- A universal basic evidence-based curriculum in cariology that could adapt to different types of health systems would be advantageous to uniform caries management across all age groups; agreement: 100%.

- A universal, evidence-based, caries record system would be advantageous to provide reliable and comparable caries diagnosis data; agreement: 93.7%.

Cariology teaching and separation between cariology and restorative dentistry:

- Cariology is not an acknowledged discipline or subject area in my dental school; agreement: 37.5%.
- There is insufficient curriculum time for cariology teaching, other than restorative dentistry, in my university; agreement: 50%.
- There is improvement needed in the understanding by dental schools of the importance of teaching cariology in dental training; agreement: 81.2%.
- Ideally, a single department should be involved in teaching of cariology and restorative dentistry; agreement: 81.2%.
- Cariology and restorative dentistry are often taught by different departments (groups), and each department has a different approach, which makes connections challenging. Thus, having common faculty groups involved in teaching both cariology and restorative dentistry will enhance communication and collaboration; agreement: 90.6%.

Focus on restorative/surgical caries management with prevention/control “disconnected”:

- Caries management in my dental school is still centered primarily on operative intervention in almost all dental specialties (e.g., pediatrics, geriatrics, etc.); agreement: 68.7%.
- Changing the way caries is managed (shifting the emphasis from cure to care) in my dental school, including a focus on prevention/control and minimally invasive dentistry, represents one of the greatest challenges to implement fully the CCC at my university and in clinical practice; agreement: 90.6%.
- In my dental school, caries control/preventive activities target mainly children. Preventive activities for adults/permanent teeth are scarce or nonexistent and not reimbursed; agreement: 65.6%.

Lack of available eLearning for implementing the CCC:

- There is in general lack of suitable and widely available eLearning options for dental and dental hygiene student teaching, particularly for schools with limited faculty expertise in cariology; agreement: 65.6%.
- Today and after the emergence of the COVID-19 pandemic, there is a further essential need for the implementation of minimally invasive dentistry, and a greater emphasis should be placed on the importance of incorporating the CCC for caries management in dental education; agreement: 100%.

Table 1. Main challenges for the CCC implementation in different participant universities/countries*

Key themes	Italy	Poland	UK	India	Russia	Brazil	Colombia	USA	Mean of agreement
Dental schools, n	38	10	14	324	64	563	35	70	–
National curriculum dentistry/cariology	Yes	Yes	No	Yes	Yes	No	Yes	Yes	–
National curriculum is compulsory or a recommendation	Recommendation	Compulsory	Recommendation	Compulsory**	Compulsory	Recommendation	Recommendation	Recommendation ⁺	–
Agreement on the need to implement a standard CCC	100%	100%	100%	87.5%	100%	100%	100%	81.25%	96%
Cariology teaching and separation between cariology and restorative dentistry	90%	70%	70%	90%	60%	50%	80%	35%	68%
Focus on restorative/ surgical caries management with prevention "disconnected"	100%	66.6%	33.3%	100%	66.6%	100%	66.6%	49.8%	73%
Lack of available eLearning for implementing the CCC	100%	75%	75%	100%	75%	75%	75%	87.5%	83%
Need for caries diagnosis calibration and training in dental schools	100%	58.3%	75%	100%	75%	25%	66.6%	58.3%	69.7%
Insufficient policy support and reimbursement for use of CCC concepts based on modern caries management	100%	83.3%	83.3%	100%	83.3%	66.6%	100%	100%	89.5%
Mean of agreement	98.5%	71.8%	73%	96.2%	79.9%	69.5%	80.4%	69.5%	–

CCC, Core Curriculum in Cariology. *Disclaimer: In order to summarize the information in the table, the columns have been labeled using the respective participant country name, though it is important to underline that the different "key themes" do not represent the situation in the whole country, rather a specific situation in particular university(ies) in those countries. **Only the national curriculum in dentistry is compulsory. ⁺In Michigan, the graduate's competence in caries management is compulsory.

Need for caries diagnosis calibration and training in dental schools:

- In general, there is a lack of calibration and homogeneous use of caries diagnostic systems among the different departments of my dental school; agreement: 84.3%.
- Initial caries lesions are still not considered clinically and/or radiographically as part of the caries diagnosis in my dental school; agreement: 31.2%.
- Internal training/calibration of dentists teaching cariology/restorative dentistry in my dental school is an ongoing need and/or not adequate; agreement: 81.2%.
- There is no interest on internal training/calibration of dentists teaching cariology/restorative dentistry in my dental school; agreement: 53.1%.
- Training/calibration of dental students in my dental schools on caries detection and diagnosis is a need and an ongoing challenge; agreement: 75%.
- We train/calibrate our dental students to detect and diagnose caries lesions according to contemporary criteria (e.g., using ICDAS); agreement: 93.7%.

Insufficient Policy Support and Reimbursement for Use of CCC concepts based on modern caries management:

- In my country, there is not enough policy commitment to the reimbursement of contemporary caries prevention and management strategies; agreement: 93.7%.
- In my country, there is a gap between what dental students are taught about caries diagnosis and management in dental schools and what happens once in practice due to existing workflow issues; agreement: 87.5%.
- There has been a movement in the last decade (e.g., from ORCA with the CCC and Alliance for a Cavity-Free Future [ACFF] consensus policies) to integrate contemporary cariology into the curricula of dental professionals at university/national/international level; however, this remains an ongoing challenge in my dental school; agreement: 87.5%.

Discussion

In view of the caries situation globally, with around 2.4 billion people affected by dental caries in permanent teeth and 486 million children who suffer from caries in primary teeth, with a clear variation in the disease occurrence between regions and countries in the world [14], it is imperative to improve implementation and dissemination of evidence-based best practices in caries man-

agement. Yet in order to do so, we need a dental workforce adequately prepared and trained in all aspects of cariology.

The CCC was developed as a strategy for providing a conceptual framework and homogenizing the teaching of cariology. It has been discussed and partially modified in several parts of the world [8–13, 15, 16]. However, among those who are familiar and have experience with the CCC (focus of this manuscript), various challenges for fully CCC implementation persist. The workshop presented specific geographical insights and implementation challenges of the CCC from 3 European countries (Italy, Poland, and the UK), 2 Asian countries (India and Russia), 2 Latin American countries (Brazil and Colombia), and the USA (Michigan and IA). Participants/countries were selected based on their previous commitment and experience in the implementation of the CCC. The findings reported here are not intended to represent the situation in the entire country mentioned, but rather to bring a multinational perspective to the discussion of the main challenges for implementing the CCC. Therefore, our findings cannot be considered to represent what is happening at the national level, especially in countries with a large number of dental schools.

Main findings of this study confirmed that there is a real interest in implementing a standardized CCC in various dental schools in different parts of the world (agreement: 97%). However, major concern remains in the lack of agreement on a CCC by all universities in a country (94%). In addition, our results showed that the content and time at which students are exposed to caries-related subjects during their studies, as well as the pedagogical modalities used, and the hours devoted to learning, vary greatly. The intention of the CCC is not to establish a rigid standard in which cariology should be thought; instead, it intends to offer a content framework, which might be modified, considering the variety of influencing factors at the country/region/university level (e.g., changes in disease prevalence in a specific country/region, reimbursement possibilities for use of caries management strategies, possibility of using specific materials and technologies, cultural and behavioral competencies, interprofessional education, etc.).

There have been different initiatives from different organizations such as the ADEE, the American Dental Education Association (ADEA), or the ACFF among others, as well as from universities in different countries/regions in the world (e.g., USA, Colombia, Chile, Asian countries) to promote the implementation of the CCC, and various specific workshops on the CCC have been conducted. At the local level, the CCC is

considered as a framework of what needs to be taught, with modifications considered when appropriate to local realities. For example, in Colombia, in order to reach a consensus for an undergraduate cariology teaching curriculum among the Colombian dental schools, a collective national consensus was reached among the 26 dental schools in the country. Adaptation was made in accordance with the culture, health system, and disease prevalence given a general focus on social determinants of health and with, for example, more emphasis on fluorosis than on erosion [8]. Recently in Latin America, Latin American Oral Health Association (LAOHA) has been working on a Latin American consensus on cariology teaching for dental schools under a framework of “Call to Action.” LAOHA selected a panel of experts from regional institutions and dental schools from 21 countries, as well as external peer experts from international organizations such as ORCA, the American Academy of Cariology (AAC), the World Dental Federation (FDI), and the International Association of Paediatric Dentistry (IAPD). The outcome of this effort has been the participation of 129 academic/professional institutions to help craft and consent on a document called “Latin American Consensus on Cariological Education for Dental Schools.” The document remains to be implemented. This Latin American initiative could serve as an inspiration to other countries/regions in the world facing similar challenges for the implementation of the CCC.

On the other hand, our panel partially agreed that cariology is not always considered as a recognized discipline (38%), nor it is taught/coordinated by one department/division, but rather cariology content is often distributed under different disciplines such as public health, operative, pediatric dentistry, etc. (91%). Consequently, the concepts are often taught to students by different faculty, with limited integration. Comparable findings were reported in a previous study assessing the education in cariology for dental students in Australia and New Zealand [16]. In addition, agreement (81%) was reached when participants were asked about the possibility of a single department being responsible for the organization of teaching cariology and restorative dentistry. Nevertheless, participants consider important that common faculty groups should be involved in teaching both cariology and restorative dentistry, which will enhance communication and collaboration (91%). In light of current paradigms in caries management, both preventive and therapeutic approaches for all age groups need to work in conjunction with each other to promote pa-

tient health outcomes. In many healthcare systems around the world, oral health preventive strategies tend to be predominantly focused on children and sometimes the elderly, while adults often face a gap in access to preventive care. This disparity arises from the well-recognized importance of early dental prevention for children to establish lifelong oral hygiene care habits and the recognition of the vulnerability of older adults to dental issues. Addressing this gap in promoting preventive dental care across the entire lifespan is crucial to ensuring lifelong oral health and reducing the burden of preventable dental issues in the adult population. A holistic approach to caries management for all age groups would be beneficial into the organization of patient care taught and provided in dental schools, with an emphasis on interdisciplinarity, so that the links of content taught across disciplines are discussed, synthesized, and harmonized into a coordinated and coherent whole, rather than working in multidisciplinary groups without common and related goals. Ideally, this will be reflected in the way that students will understand and manage the disease in a comprehensive way after graduation, incorporating preventive, nonoperative care and, where necessary, operative caries management in an integrated manner. In addition, efforts to disseminate the current holistic approach of caries management (prevention, non-restorative and restorative approaches) should be made at national and international restorative organizations not only to focus on dental students’ education but to focus on training and calibrating today’s practitioners. As an example, the Academy of Operative Dentistry in the USA (<https://academyofoperativedentistry.com/>) recently established a cariology committee to disseminate annually updates in the area of cariology and its integration to restorative dentistry.

Additionally, it has been pointed out (agreement >87%) that insufficient policy support and reimbursement for use of many aspects of modern caries management is a limitation for successful CCC implementation. The lack of supportive policies represents in fact a gap between what dental students are taught about cariology in dental schools and what happens once in practice, such as time constraints for detailed caries diagnosis, lack of a easy means for recording initial carious lesions, preventive, nonoperative, and minimally invasive therapies neither considered nor reimbursed, etc. [17]. To identify disparities in caries management behavior between university settings and real-world practice, in Colombia, a questionnaire based on the capability,

opportunity, and motivation-behavior (COM-B) model was administered to 1,094 participants (dentists: $n = 277$, educators: $n = 212$, and students: $n = 212$) who were asked to report on how they diagnose and manage carious lesions. The results showed that students conduct risk and caries lesions assessment more often than educators, and those more often than practitioners. In addition, for all the three groups the least frequently reported caries management behavior was the use of nonoperative care for initial/moderate carious lesions. Opportunity (resources available and relevance) was the best COM-B predictor for including diagnostic behaviors, e.g., including radiographic caries lesion assessment [18].

Surveillance of dental health and dental care is particularly required to support quality improvement, resource allocation, and long-term planning of dental care. In addition, valid data for health economic analyses are also indispensable for health resource allocation and long-term planning of oral healthcare strategies [17, 19]. With these already well-known needs in mind, almost all participants agreed (94% agreement) that a universal, evidence-based caries registration system, adaptable to different types of health records, would be advantageous in providing reliable and comparable data on caries diagnosis, over time and across institutions, nationally and internationally [20].

In light of the findings from this study, it is essential to carefully consider its limitations. First, we identified a single individual working at the university level in a country where the CCC had been discussed and partially adapted. This person, to the best of her/his knowledge, represented and presented the situation in her/his setting. This singular perspective could potentially have introduced a significant limitation into the reported results. However, it is important to note that participants have been intensively involved in the CCC discussion/adaptation in their countries and were explicitly encouraged in their presentations not to confine themselves solely to their institutional viewpoints but to also provide a broader national perspective on CCC implementation, emphasizing the challenges at the university and country levels. On the other hand, our chosen methodology allowed us to identify challenges related to CCC implementation but did not afford the opportunity to investigate the various types of barriers, nor how these barriers could be or were overcome. Alternative methodologies, such as the COM-B model strategy [21], commonly used to pinpoint the changes required for effective behavior change interventions, considering factors like capacity, opportunity, and motivation, could have provided

additional insights and strategies to support CCC implementation and may be considered for future experiences. It is worth noting, however, that we initially decided to address the issues of challenges and solutions in separate meetings as part of our study outline. The 2022 Education Platform meeting primarily centered on presenting the challenges associated with CCC implementation, while the 2023 meeting was dedicated to actively discussing solutions and strategies (a manuscript on this topic will be forthcoming). Consequently, the present paper predominantly addresses the challenges; nevertheless, it also touches on some ideas for improvement that were discussed.

We conclude that several challenges remain in the implementation of CCC, with a need to better integrate cariology into the various components of dental education. The integration of cariology and restorative dentistry remains essential, so that the students realize the interconnection between preventive, nonoperative, and operative dentistry, thus enhancing evidence-based decision-making and resulting in a shift of emphasis from a disease focus (operative care) to a health focus (caries prevention and nonoperative care). On the other hand, the lack of political support for financing modern diagnostic and management strategies for caries control in many parts of the world remains a major challenge to be addressed at the international level. The efforts of international organizations, e.g., ORCA or ACFF, should continue to be focused on helping address this challenge.

The CCC remains a useful framework for curriculum development at university or national/regional level, and for the most part, it reflects current evidence needed for management of caries and other dental hard tissue disorders. Nonetheless, considering new concepts on caries management and other related disorders, some aspects could benefit from updates (e.g., prevalence of incisor molar hypomineralization, availability of silver diamine fluoride, updates on strategies to manage erosive tooth wear, role of artificial intelligence in caries detection and management, etc.). In the short term, this is in ORCA's plans, certainly with other international stakeholders' collaboration.

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Statement of Ethics

An ethics statement was not required for this study type, as this study solely reports the findings of a meeting on challenges for the implementation of the CCC at university/country. Written informed consent to participate was not directly obtained but inferred by participation in the meeting. All participants willingly agreed to present their views, and their input was recorded and summarized for the purpose of this paper. No human or animal subjects or materials were used.

Conflict of Interest Statement

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Author Contributions

Ruth M. Santamaría, Margherita Fontana, and Christian H. Splieth prepared this paper based on the findings of the ORCA 2022 meeting, Education Platform; the statements were discussed and voted on by all of the authors (Renata Chalas, Sandra Guzman-Armstrong, Justine L. Kolker, Jogikalmat Krithikadatta, Irina Kuzmina, Marisa Maltz, Stefania Martignon, Livia Ottolenghi, Nigel Pitts, and Maria Abdin). All of the other authors (Ruth M. Santamaría, Margherita Fontana, Renata Chalas, Sandra Guzman-Armstrong, Justine L. Kolker, Krithikadatta Jogikalmat, Irina Kuzmina, Marisa Maltz, Stefania Martignon, Livia Ottolenghi, Nigel Pitts, Maria Abdin, and Christian H. Splieth) corrected and approved this paper.

Data Availability Statement

All data generated or analyzed during this study are included in this article and its online supplementary material files. Further inquiries can be directed to the corresponding author.

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