



Raising Awareness for Agrifood in Secondary Schools with a Genomics Cookbook

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Abstract

How to encourage students to choose for a future in agrifood? Not like we always did. The labor market shows an increasing shortage. The agrifood sector plays a significant role in achieving global food security and environmental sustainability. Scholars hardly realize what they can contribute to these social, ecologic and economic issues. The sector needs to expand the range of career opportunities in the agriculture-food-nutrition-environment nexus. Most importantly, it means creating incentives that encourage young people to see agrifood as one of the best options for a career choice.

We developed inspiring learning materials to achieve awareness in secondary schools in the Netherlands. A Genomics Cookbook with food metaphors to explain biological principles is highly appreciated by both teachers and students. It is a way to increase influx into green colleges and universities, and thereby efflux to the agrifood sector.

Keywords: DNA, Education, Employability, Green University, Learning Materials, Molecular Biology, Personalized Nutrition, Talent Development

Introduction

General Introduction

Inflow of young people in the labor market is one of the biggest challenges in the agrifood sector. A flourishing agrifood sector cannot exist without the influx of sufficient and well-trained employees. In general, too few young people choose for a study and job in the agrifood sector. More than 1 billion people worldwide work in agriculture. According to the Food and Agriculture Organization of the United Nations [1], the agricultural sector still accounts for 45 percent of the world's labor force. The percentage is higher (55%) in poor countries than in rich countries, and remarkable increases in productivity and added value can be observed per country [2]. The agrifood sector is essential for the Dutch economy. The Dutch agrifood companies occupy an internationally prominent position across the entire breadth of the sector. A total of 12 (30%) of the international top 40 companies are active in the Netherlands. With a total added value of € 48 billion, the sector contributes nearly 10% to GDP and 10% to total employment. The agrifood complex is by far the largest economic sector in the Netherlands. In order to retain sufficient employees within agrifood in the future, something must be done. There is an aging population, a decline of young people, and a limited intake of students in "Agrifood-education". The labor market, government and knowledge

institutes have the task of improving the image of the agrifood sector and must together ensure a quantitative and qualitative inflow into the food labor market. Change can only take place in a triple helix cooperation.

“Change in education is easy to propose, hard to implement and extraordinarily difficult to sustain” [3].

In this paper the focus will be specifically on the Dutch situation and we will attempt to translate this into the global issue. We will illustrate our approach by providing an example of cross medial communication to reach young people in order to trigger them for a choice in the agrifood sector. The exemplification in the methodology -, results- and discussion section is preceded by a literature study in the next section in order to provide the perspective from which our approach has to be understood.

We hypothesized that addressing the attention of young people for biology and thereby raising awareness for future possibilities in the agrifood sector may be a promising way to raise the interest of new generations of employees in the sector. Positive responses from teachers, students and also parents encouraged us to share our experiences and to illustrate how an increase in the desired awareness was achieved.

Brief overview of relevant literature

The image of the agricultural sector is determined by the image that the citizen has of the entire sector: the agricultural companies, the farmer or horticulturist. The agricultural sector benefits from a good image. The image determines the extent to which agricultural entrepreneurs have room to produce food, both on the national and international market (license to produce). The image also determines whether young people choose an agrifood study. Image enhancement of the Food sector can be achieved by storytelling and introducing young adults, parents and labor potentials to the sector's innovative and versatility, future-proof products and innovative developments such as personalized food, career opportunities and circular solutions for major social issues: food supply, biodiversity and climate change.

Cooperation between government, knowledge institutes and labor market is important for improving the image of the sector and for attracting employees and students. Within the so-called triple helix, entrepreneurs, education and governments work together on challenges and the realization of innovations, attracting talent (human capital) and positioning. Within the triple helix, the government has the role of a matchmaker that brings parties together, a driver of innovation and a facilitator that removes obstacles and regulatory pressure and arranges a match between supply and demand for qualified personnel. Entrepreneurs provide jobs and economic growth. Knowledge

institutions are enabled to make their knowledge more accessible to businesses in various ways.

The world is changing rapidly, the labor market also, and knowledge institutes are facing the challenge of moving education along. Courses that have a good view of what students need in terms of knowledge, skills and attitudes to be well equipped for their future work, and that thereby optimally support the learning process, are future-proof. To achieve this, modification and variation is needed. In order to function in the changing work field, employees not only need substantive knowledge and skills within a single domain, but also skills that go beyond their own domain. We call it advanced skills or 21st-century skills [4].

Traditionally, the focus of education has been on cognition. In the 21st century, the “Know” focuses more on conceptual thinking than on remembering facts. The “Do” has shifted from remembering and describing to complex and interdisciplinary skills such as communication, collaboration, critical thinking, information management and creativity. Focus of “Be” is on mental health, personal growth, socio-emotional learning, and values and attitudes. The goals of the “Know, Do and Be” model are: lifelong learning, creating and maintaining healthy relationships and developing the values to successfully participate in society. The “Know, Do and Be” are interconnected and interdependent. Twenty-first century capabilities are not taught in isolation but rather are taught within a core body of knowledge [4]. Competencies are acknowledged as necessary for successful 21st Century living and should be a central focus of curriculum. Easy or not, the need to address 21st Century competencies in our classrooms is pressing [5]. To be able to design and structure education in such a way that the learning process of students is well supported, it is useful to look more closely at how a learning process takes shape in its basic form [6]. A curriculum must offer sufficient authentic assignments, in increasing complexity, within which students are given the opportunity to develop into T-shaped professionals, within which they can collaborate and create knowledge in interaction. Optimal learning also depends on how learning processes take shape: 1) collaborative learning within and outside one's own discipline, 2) self-regulated learning and 3) reflective learning. These three learning processes are closely related to 21st-century skills.

Education must train students to become skilled employees and entrepreneurs. Offering suitable teaching packages ensures that students become acquainted with practice and opportunities within the food sector. The education and training offer must be (better) tailored to the needs of the business community and must also be in line with the interests and way of learning and developing of adolescents. The labor market relevance of the training offer must play a (greater) role. This is only possible through cooperation in the triple helix.

Many students, next employees and next generation entrepreneurs are born between 1997 and 2012 (age 9 till 24 in 2021). They are called post-Millennials or Generation Z [7], a generation that grows up in a world with relatively little limitations and that lives in a 24/7 information society. Between the 12th and 20th year of life is the forming period where individuals test opinions, adopt norms and values. Generation Z focuses on results and assessment of results; does not like hierarchy and focuses on self-development; works to live and sees no separation between work and private life. Generation Z is a network generation. For them, sharing information is natural, just like sharing contacts. Internet is the primary basic needs of Generation Z. Because so much information is available, the young people from Generation Z are aware that they will never know it all [8]. Generation Z is not characterized as "abstainers", but more as "finders"; they search the mass information for the right knowledge. Generation Z is an independent generation that likes to choose independently. When making choices, Generation Z looks for people in their network who know the dilemma in question and can provide advice. Generation Z is looking for advisors from their own network, with whom they feel connected and who can help them make the choice. The freer the choice, the more Generation Z works together to make the choice. Generation Z starts at the top in the Maslow pyramid of self-development [9]. As a result, they are primarily focused on themselves, they are self-reliant and have self-management [7,8].

Next to generational issues the biology of the brain of adolescents should also be taken into account. Adolescents experience infatuation more intensely, cannot plan, take on parents and can change mood quickly, have no trouble with complex internet technology and may think that they themselves can change the world. For the outside world adolescents are sometimes considered difficult or lazy. Brain examinations have shed new light on the developmental stages that play a role in adolescent behavior [10]. The examinations of magnetic resonance images show the phase of brain development that an adolescent is in. Different areas of the brain develop in different ways and times. The brain is best equipped in a certain specific period to learn a certain specific skill.

During the early (age 10-15 yr) and late (age 16-22 yr) puberty, the largest changes occur in the brain. This mainly happens in the anterior parts of the brain, the so-called prefrontal cortex. Most planning and monitoring functions are located in this area. These functions enable people to plan, anticipate and oversee the long-term consequences of their actions. These planning and control functions only become mature in late puberty [10,11].

The traditional curriculum concentrates on useful 'knowledge' and 'basic skills'. Unfortunately more general strategies of learning such as solving problems, using memory

effectively and selecting appropriate methods of working, are often neglected. Learning to learn involves learning strategies like planning ahead, monitoring one's performance to identify sources of difficulty, checking, estimating, revision and self-testing. Effective learning demands more than this: skills and strategies have to be learned in such a way that they can be 'transferred' to fit new problems or situations not previously encountered. Being able to select the appropriate strategy, and to adapt it where necessary. Learning to learn depends on developing a 'seventh sense', an awareness of one's mental processes. Cultivating this seventh sense should be one of the prime aims of the curriculum. One of our aims is to encourage teachers to start thinking about some different approaches to harnessing the potential of young learners [12].

Theories of learning styles suggest that individuals think and learn best in different ways. These are not differences of ability but rather preferences for processing certain types of information or for processing information in certain types of way. If accurate, learning styles theories could have important implications for instruction because student achievement would be a product of the interaction of instruction and the student's style. There is reason to think that people view learning styles theories as broadly accurate, but, in fact, scientific support for these theories is lacking.

Learning styles theories are varied, but each of these theories holds that people learn in different ways and that learning can be optimized for an individual by tailoring instruction to his or her style. Researchers have defined "learning styles" in several ways. The definition would include learning styles theories that differentiate between visual (best by watching), auditory (best by listening), and kinesthetic (best by moving) learners. Learning styles theories based on preferences for certain types of cognitive processing would include distinctions between intuitive and analytic thinkers or between activist, reflecting or pragmatic thinkers. The theories about learning styles suggest that a good understanding of student differences improves instruction. For many, learning styles offer a middle way between treating each student in the same way and treating each student uniquely [13]. Learning styles refer to the ways in which learners perceive, understand and conceptualize information. Optimal learning occurs when instructional practices acknowledge and affirm diverse learning styles. Discussion on learning styles is well documented in the literature: see for instance references in [14] for source information on Kolb's model from 1984, Felder and Silverman's learning style model from 1988, the Herrmann brain dominance instrument from 1989. Also relevant are the Myers-Briggs type indicator; the Dunn and Dunn model [14] and additional studies on the use of social media in education [15].

It is a well-known fact that students enjoy learning more when their motivation is addressed. Ryan and Deci [16] describe the Self-Determination Theory for motivation and

development. This commonly used theory touches upon all spheres of human life: education, work, and everyday life. In the frame of this theory, motivation is divided into autonomous (internal or intrinsic) and controlled (external or extrinsic) motivation. According to [16] “autonomous motivation involves behaving with a full sense of volition and choice, whereas controlled motivation involves behaving with the experience of pressure and demand toward specific outcomes that comes from forces perceived to be external to the self”. Adapting this theory to education is based on three basic psychological needs that must be met in order to get and keep students more intrinsically motivated: sense of autonomy, control and social connectedness. Researchers and writers of this paper have experience and therefore add “fun” to this theory.

Teaching practices have evolved over the last twenty years, with more emphasis on student-centered pedagogy. The time is ripe to take managed risks and explore creative methods of learning and teaching. The learner’s journey and their experiences along the way must meet student expectations and offer a more dynamic and appropriate pedagogy [15].

The interaction between teacher and student influences student motivation. The choice of educational style plays a major role in student motivation. Combining educational styles based on student needs, interests and preferences delivers more productive educational outcomes. To increase the motivation level and allow more students to choose a study, it is advisable to create the most comfortable learning environment for each specific student group. It is important that teachers organize their educational strategic plans well and flexibly.

A current development that invites for new curriculum components is “Personalized Nutrition,” i.e., the food supply that is optimized for individual demands, both from a technical (DNA-technology; food processing technology; food supply chain consequences) and a human (consumer and/or patient specific demands and its impact on food supply chains) perspective. Personalized Nutrition therefore provides an excellent topic to be used for a cross-over approach to appeal the students of the future.

Methods

Based on the concepts described in the previous section, a learning tool was developed with the aim to attract students of the future and raise goodwill within a community of teachers involved in green education programs in high schools. The project was called “Genomisch Kookboek” (“Genomics Cookbook”) and support was obtained from various triple helix cooperations with Universities of Applied Sciences (UASs) in The Netherlands. The triple helices included the Food Circle project [17], the Centre of Expertise Healthy

Ageing [18] and the Centre of Expertise Food [19], with additional support from the Education Innovation Program Food & Consumer of the ministry of Economic Affairs.

Aided by a professional organization called “De Praktijk,” experienced in the development of learning tools for various types of Beta studies, a team of UAS teachers with expertise in Agricultural Sciences, Food Technology, Biology, and Facility Services guided each other, their colleagues and students in the development and testing. The desired learning tool had to combine several types of information transfer, had to be appealing for Generation Z as well as for their teachers and -not to forget- their parents. From within the network of De Praktijk, a number of high school teachers was found willing to test ideas within their classes, and to help in choosing the right topics for the limited number of chapters we had in mind.

The learning tool thus was based on the classic concept of a book, with natural extensions to online sources of information. The aim was to develop a “Genomics Cookbook” that explains basic concepts in molecular biology, cell biology and genomics at a level that high school students can comprehend and that helps them to broaden or deepen the knowledge they need for their final exams. It does so by using food as an appealing way to make abstract material visible and understandable. The idea was to combine three types of books commonly used hands-on as “hardware” (i.e., comics book; textbook; cookery book) and invite students to go online for further information, and to practice their knowledge in games. Therefore, supplemental online material for both teachers and students was developed. Our approach for the development of the three book types and additional materials will further be exemplified below.

The book is a comics book with 6 chapters composed of small series of comic-photo’s with text balloons, that tell a short funny story using metaphors from the world of food. In the development of this tool the following principles were followed in order to reach a means of communication that appeals future students as well as their teachers:

The comics of the book should relate to known principles of the world of comics, i.e., basic monochromatic colors should be prominently used to stay close to the world of Donald Duck, Spider Man, The Simpsons and South Park (to name a few); text balloons should be used with easy to read small texts in it; a set of six pictures should tell the story, which in itself should be easy to understand and may have a (predictable or arguable) funny ending.

The comics should be up to date in terms of the methods used to produce them. At the time of development the “fotostrips” (Dutch for “photo comics”) that were produced by Ype Driessen [20] just started to reach a bigger audience (e.g.,

these comics are nowadays part of the Dutch newspaper “Het Parool” every Saturday).

Within each comics story, a second layer of information should be disguised in order to be revealed in the next part of each chapter (the classic text book part) and within the lessons where teachers and fellow-students discuss and provide explanations. The story of the comics should bridge the real world (with some connection to food consumption) with the abstract world of concepts in biology.

In all chapters and each comics story, the used metaphors from the world of food, in order to explain abstract concepts from the world of biology, should be applied consistently (always the same metaphor for the same explanation).

The comics should appeal to adolescents and use examples from their world of experience. E.g., the use of WhatsApp examples (messages going viral), and other upcoming social media at that time, was encouraged.

The book should also be a classic textbook with illustrated explanations of biological principles that underlie each topic addressed in the comics. For this we were kindly helped by an online available not-for-profit learning platform: Bioplek.org. Within The Netherlands, Bioplek.org is a popular platform, widely used by high school pupils to better understand certain issues and also to find illustrative learning materials for their projects and end products (reports). Examples of the illustrations used by Bioplek.org can be found on the bioplek website [21]. We slightly adapted the colors of the pictures to stay true to the principle we applied in other learning tools (e.g., DNAbAND® is a velcro model to explain DNA replication in classroom settings [22]): the use of complementary colors for complementary bases in double stranded DNA. This principle is highly useful and was firstly applied in the ground breaking textbook “Biochemistry” of Lubert Stryer [23]. For that reason the colors for certain bases is different in our learning tool than in the pictures of Bioplek.org. Additional pictures of beads-on-a-string representations of proteins such as insulin were produced by ourselves.

The book had also to be a cookery book to give each chapter a practical twist and to make a relation to the real world. The recipes in the book should be appealing for adolescents. Therefore, we chose to develop a series of recipes together with our own students and interns. These studied for a bachelor degree in Food Technology; Food Business; Dietetics, Biology and Medical Research, or Biotechnology. The recipes were tested for their applicability by students from the same studies but from another University of Applied Sciences. Tasting sessions for students and staff were

organized by the students to gain their experience in organizing these types of events. The sessions were necessary to test whether recipes had to be adjusted or simplified.

In addition to the hard cover glossy magazine that would result from the design described above, study materials to be downloaded online was also developed.

For the pupils a manual was designed that contains additional exercises to better prepare for understanding the chapters of the book, and it contains gaming materials to practice the knowledge with fellow students. This is also meant to be inviting for other children and adolescents to raise interest (i.e., friends and peers from other high schools). For the teachers a manual was designed to help them prepare the lessons by extensively explaining the metaphors used (leading to a list of “translations” from “food” to “biology”). This manual also was made to provide supplemental materials to be used in the classroom: a game to be played in group settings to test their knowledge. Finally a set of information was to be included to relate the content of the “Genomics Cookbook” to the official Dutch exam program for HAVO (higher general education, a 5 year high school program suitable to enter a UAS) and VWO (preparative scientific education; a 6 year program at the highest high school level, suitable to enter an academic university or a UAS).

Results

Addressing the attention of young people for biology and thereby raising awareness for challenges in the agrifood sector may be a promising way to attract new generations for a future in agrifood. Positive responses from teachers, students and parents encouraged us to share our experiences.

The Genomics Cookbook (Dutch: “Genomisch Kookboek”) is a glossy learning tool developed by educational program designers from the creative industry together with teachers and students from UASs in The Netherlands. The teaching material is substantiated by online availability of the cookbook itself as pdf as well as online tutorials (manuals) for high school students and high school teachers. The tool combines three book types (comics book, textbook, cookery book) in order to encourage next generation students to open their mind for “personalized food.” The use of metaphors is a central theme. E.g., cookbooks represent chromosomes; recipes represent genes; food products represent proteins, etc. **Figures 1, 2 and 3** illustrate a comics story that was used for chapter 1 and explains how an abstract phenomenon (the fact that RNA is usually rapidly degraded whereas DNA is not) can be made visible and understandable in an everyday situation.



Figure 1. Comics to explain genomics (1). The first two pictures of the comics in Chapter 1 introduce the idea behind the metaphorical approach. The girl shows the cookbooks she has obtained from her parents: 23 from each. The cookbooks represent chromosomes, and the text is comparable to DNA information, thus recipes represent genes. Note the small differences in titles of the books (single letters differ) that can be seen when a closer look is taken. The second picture shows the need to go out in order to retrieve ingredients, and this stands for the need to prepare a temporary message, the shopping list (a molecule of mRNA), that leaves the room with information (the nucleus). Students understand that consumers rarely take their cookbooks from home to a supermarket.



Figure 2. Comics to explain genomics (2). The second two pictures of the comics in Chapter 1 show the importance to stick to the instructions and highlight (circle in the right side illustration) that after the shopping is done, the shopping list has to be thrown away to avoid confusion with future shopping events. This is the central point of this chapter (RNA molecules have to be rapidly degraded to allow their temporary function as messengers), and it is addressed in the cookbook from other angles as well.



Figure 3. Comics to explain genomics (3). The final two pictures of the comics in Chapter 1 show the importance of the order of letters (the sequence) in order to make a successful gene product (a molecule of protein) as represented by the pie. The “pointe” of the story is hard to translate from Dutch to English, it strongly relates to an old joke about a rabbit with long teeth that repeatedly asks for carrot pie and at the time such a pie is presented simply says (speaking with a lisp due to its long teeth): “vies hè?” (“awful isn’t it?”). Note the use of monochromatic colors in the comics. Also the student house environment shown was deliberately chosen to appeal to final year high school students.

After testing with a small group of dedicated high school teachers one gross change was made in the content and smaller iterations of the content were also taken into account. The gross change in content concerned the fact that two chapters were combined to one in order to make room for a separate chapter on the topic of cell division. High school teachers explicitly demanded to include this topic because of their familiarity with students having problems to overcome the abstract steps in the chromosome behavior that precedes cell division. For that reason, this topic was included, although the topic itself is more a cell biological item that does relate to a lesser extent to the genomics issues treated in the rest of the book.

The first edition of the “Genomisch Kookboek” was launched in January 2015 at a yearly congress of high school teachers in science, health and technology [24]. A total of 15,000 copies was printed in the first edition and distributed to interested high schools in packages of 60 copies per box. Within two weeks all 15,000 copies were ordered for and a second edition was prepared. A total of 23,000 copies has now been distributed in The Netherlands and a part of those are still in use, mainly by biology teachers. We left the teachers free in their choice how to use the tool: either as a single-time issue for students to take home, or to use it in a cyclic way by giving the magazines out and let the students turning them in after class. After the launch the online material was assessable for students via NEMO, the science and education museum [25] that took over the archives of De Praktijk. The teacher instructions were deliberately held apart and assessable via websites that were only communicated to teachers. All three

pdf items can now be downloaded from the green library GreenI [26]. Free copies are still distributed to encourage potentials to choose for a future in agrifood.

The textbook sections are supported by illustrations that were derived from Bioplek.org (Figure 4), a well-known and open access study website for high school students in The Netherlands. Each chapter ends with an easy to make recipe, suitable for high school students to apply at home, with a photo illustration of each final food product. The recipes were developed and tested by Dutch students in food commerce, food technology and dietetics departments at different sites. For UAS students it was not a straight-forward course to end with easy to make food concepts for high school students. The first series of recipes developed were far too complicated to be made at home, so for the UAS students it was an eye opener to what extent the requested information had to be simplified. In the end, every recipe indeed was healthy and sustainable in its basics, easy to make with not too many ingredients, and inviting for students to eat more vegetables. The food photos used to illustrate the recipes were also made by a student.

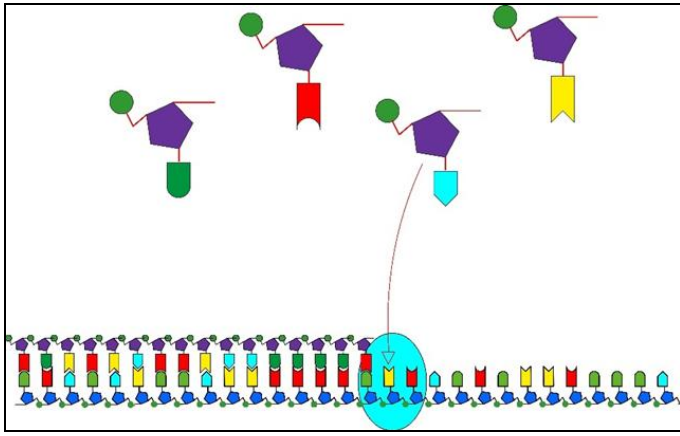


Figure 4. A textbook-type illustration. The Genomics Cookbook uses drawings derived from Bioplek.org to explain the molecular processes, in this example the transcription of genetic info from DNA into RNA. Bases G, C, A and T in DNA are copied into a complementary strand of RNA with the bases C, G, U and A, respectively (note the slightly different color green for T in DNA and U in RNA). The sugars in DNA are blue (deoxyribose) and in RNA purple (ribose) with the connecting green balls representing phosphate units. The addition of an appropriate new nucleotide in the RNA strand is highlighted in blue.



Figure 5. The Genomics Cookbook. The glossy magazines (one shown closed at the top left and one opened with a rice salad recipe at the top right) are provided as hardware study material but can also be downloaded as pdf. The latter is also true for the tutorials (manuals) for high school teachers (bottom left) and high school students (bottom right).

Workshops at the launch during the congress in 2015 as well as two additional “teacher days” provided positive feedback from teachers that chose to use the tool. During the “teacher days” (one in Amsterdam and one in Leeuwarden) additional workshops were provided on other teaching tools that were developed prior to the Genomics Cookbook and that had proven to be raising goodwill in the teaching community

as well, e.g., DNABAND® [22] and the living JigSaw puzzle [27].

Discussion

Teachers of final years high school students are very much open for new study materials that provide attractive up to date content. However, in order to develop such tools by professionals, whether or not in collaboration with volunteers and students, is a costly road, especially when hard copies of glossy books have to be distributed. To provide hard copies in the program was recommended as essential by cross-media professionals, in order to give the study material a chance on prolonged attention. Glossy magazine-like printed material is kept longer in possession compared to newspaper-like prints and redraws the attention of the owner when it is rediscovered somewhere later, e.g., at home. As an additional resource, an electronic version of the material is very much appreciated, especially when it is easily accessible. For that sake we made a pdf of the Genomics Cookbook accessible through various websites. Indeed, according to research findings 62% of university students state that they use e-books and the ratio of electronic resource users is 53% while the ratio of printed resource users is 47% [28], whereas research from 2009 showed that students preferred e-book with a ratio of 11%, printed resources with a ratio of 26% and both resources with a ratio of 56% [29]. According to a 2013 study, students read mostly (87%) novels etc. as printed books [30] and as e-books they place research books (87%) to the first rank and course materials to the second rank (75%) and publishers should consider the publishing of e-book as a requirement.

Primary target groups of the “Genomisch Kookboek” are students in their final year of secondary school that prepare for higher professional and scientific education. Therefore, the teaching materials were tested in close collaboration with several teachers that allowed us to practice within their class room and that gave constructive input for adaptations in the chosen approach and content. These teachers were teaching Biology to pupils at level 4 and level 6 of the VWO (preparative scientific education; the highest level of high school within The Netherlands). Target groups were level 6 VWO and level 5 HAVO (higher general education; the second highest level of high school in The Netherlands), therefore the teaching levels of the test groups were appropriate.

A second target group of the Genomics Cookbook could be students in other learning communities such as vocational studies in agrifood disciplines. However, this was not tested as the teaching materials was explicitly developed for secondary schools as indicated above.

A third target group may also be well served with this tool: students within Universities of Applied Sciences that do not have a specific or thorough background in biology but need to grasp the basics of molecular biological principles in order to

keep up with developments in the area of personalized food. The latter group of students is rather diverse: from dietetics, sports, lifestyle, business and informatics to food commerce and technology.

Generation Z is the first generation of true digital natives and is now entering the labor market [8]. With the search for truth at the center of its behavior patterns, this generation is open for the messages that the Genomics Cookbook intends to spread. Technology has given young people a lot of connectivity and may also be an important drive to connect in sustainable and healthy goals of the agrifood production industry of the future. For companies, Generation Z may bring both challenges and opportunities, and tools such as the Genomics Cookbook are simple exponents of that development.

As mentioned in the results section, not only students but teachers were enthusiastic as well. The “Genomisch Kookboek” was launched in 2015 and 23,000 copies have now been distributed within The Netherlands. Part of those are still in use by biology teachers and free copies are still distributed to encourage potentials to choose for a future in agrifood.

Addressing the attention of young people for biology and thereby raising awareness for future possibilities in the agrifood sector may be a promising way to raise the interest of new generations of employees in the sector. Positive responses from teachers, students and also parents encouraged us to share our experiences and to illustrate how an increase in the desired awareness was achieved. Triple helices are a valuable initiator of new developments and an excellent learning environment for students in outside-world-oriented curricula.

Conclusion

Attractive learning tools for students of the future may provide proper encouragement to choose for a future in the agrifood sector. Teachers are often open for updating their programs and stay interested in new developments. Triple helices are a valuable initiator of new developments and an excellent learning environment for students in outside-world-oriented curricula.

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