Analyzing Best Practices in Technology Education

Marc de Vries, Rod Custer, John Dakers, Gene Martin (Eds.)
ANALYZING BEST PRACTICES IN TECHNOLOGY EDUCATION
INTERNATIONAL TECHNOLOGY EDUCATION STUDIES

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Scope
Technology Education has gone through a lot of changes in the past decades. It has developed from a craft oriented school subject to a learning area in which the meaning of technology as an important part of our contemporary culture is explored, both by the learning of theoretical concepts and through practical activities. This development has been accompanied by educational research. The output of research studies is published mostly as articles in scholarly Technology Education and Science Education journals. There is a need, however, for more than that. The field still lacks an international book series that is entirely dedicated to Technology Education. The International Technology Education Studies aim at providing the opportunity to publish more extensive texts than in journal articles, or to publish coherent collections of articles/chapters that focus on a certain theme. In this book series monographs and edited volumes will be published. The books will be peer reviewed in order to assure the quality of the texts.
Analyzing Best Practices in Technology Education

Edited by

Marc de Vries
Eindhoven University of Technology

Rod Custer
Illinois State University

John Dakers
University of Glasgow

and

Gene Martin
Technical Foundation of America

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MARC J. DE VRIES

PREFACE

It is about two years ago that I received a book for reviewing in the *International Journal of Technology and Design Education*, titled: *Analysing Exemplary Science Education*. My first thought when I glanced through it was: it would be great if we would have such a book for technology education. Thus started the adventure that ultimately has led to the book that you are reading now. It certainly was an adventure because to the best of my knowledge it is new for technology education to have classroom teachers write chapters and then have experts reflect on those accounts. But it all worked out, thanks to the fact that some colleagues were prepared to join me in the adventure: Rod Custer, John Dakers and Gene Martin. Gene played an extra role because he was kind enough to let us use the outcomes of a project that he had recently done: collecting examples of good technology education practice in the USA. From the brochure that was published as an outcome of that project I was able to get immediate access to a number of examples that are now fully described in this book. I want to thank Rod, John and Gene for their valuable help in putting this book together. Also I want to thank those colleagues who helped to identify the teachers and in some cases assisted them in writing their chapters: Marie Hoepfl, Gregory Kane, and Howard Middleton.

Our field is blessed with the presence of Sense Publishers, the owner of which, Peter de Liefde, has always been a promoter of academic publications for technology education. He was the initiator of the International Technology Education Studies, a series that is published by Sense Publishers, of which the first volume was the *International Handbook of Technology Education: Reviewing the Past Twenty Years*, edited by Ilja Mottier and myself. I want to thank Peter for his commitment to the field and for the work he did to bring this book onto the market so that others can learn from reflections on good technology education practice. I hope it will make a useful contribution to the growing amount of academic technology education literature.

Eindhoven, June 2007
1. REFLECTING ON REFLECTIVE PRACTITIONERS IN TECHNOLOGY EDUCATION

Analyzing good practices as a source of educational insights

INTRODUCTION

In his well-known book *The Reflective Practitioner*, Donald Schön introduced the idea of people in practice learning from reflections on their own practice. This book takes a next step: by having theoreticians reflect on practitioners’ reflections we can gain theoretical insights. In science education an effort like that led to the book *Analyzing Exemplary Science Education*, edited by Steve Alsop, Larry Bencze and Erminia Pedretti (2005). In a school subject with such a long tradition as science education, such an effort seems quite justifiable. But how about technology education? Is not that school subject too young to allow for such an analysis to be useful? Would it not just reveal all the weaknesses and problems of an emerging field? The editors of the book took the risk and started the project of which this book is the result. It is fair to say that indeed the outcome of the project is that technology education still struggles with a number of problems. But on the other hand the book shows that good practice does exist in this field. In this introductory chapter I will describe the rationale and procedure of the project.

A RATIONALE FOR REFLECTING ON PRACTICE

One of the problems of educational research is that it is often difficult to transfer its outcomes to educational practice. This problem can be expected for theoretical research, because it takes its starting point in theory and therefore does not necessarily relate to educational practice. But even in the case of empirical educational research, it is often felt that its outcomes are of too academic a nature to be useful for educational practice. This is also the case in technology education. It may have something to do with the way such research is usually conducted. Often, it serves as a practical test of theoretical ideas. Theoretical considerations have led to certain expectations of interventions, and by applying and evaluating those interventions one hopes to gain insight into the validity of those theoretical insights. But still, the outcomes can have a strong theoretical flavor. The results are then published in an academic journal. Such journals, generally speaking, are not read by teachers. Thus a gap remains between the outcomes of the research and educational practice. It is very probable that one could improve this situation by paying more explicit attention to the ‘translation’ of the research output to educational practice, for instance by writing articles of a different nature for...
teachers’ magazines, using the outcomes of the research project as a source of inspiration for giving practical advises to teachers. And, of course, that does happen, though not as systematically and consistently as one would wish. But could there be a different, complementary way of deriving insights into how to improve educational practice?

The alternative that is the basis of this book is an approach in which we first seek examples of what we intuitively identify as good practice, and then ask ourselves the question: what makes this practice good in our intuition? This is more or less the same approach as in the ‘grounded theory’ approach, as developed by Glaser and Strauss (1967). By reflecting on a set of case studies one can derive ideas for new theoretical insights. Such ideas would be close to practice from the very start, and this can make them the more valuable for practice, once they have been tested and confirmed.

IDENTIFYING GOOD PRACTICE

It is by no means an easy task to identify good practice in technology education. In the first place there are quite different practices in a variety of countries. In a previous book in the International Technology Education Series, titled the International Handbook of Technology Education: Reviewing the Past Twenty Years (edited by Ilja Mottier and myself), a survey of the situation of technology education worldwide was presented. This survey showed the wide variety of approaches one can find in this field. Fortunately, the identification of examples of good practice as a basis for theoretical reflection does not need to be a representative sample of worldwide technology education practice. A more serious problem, though, is the question of what one considers to be ‘good’ practice. Is technology education practice ‘good’ when it helps young people develop proper concepts of and in technology? Or is it ‘good’ when it results in nicely looking and well functioning artifacts as the outcomes of design-and-make activities? Or is it ‘good’ when it prepares these young people for engineering professions, or when it prepares them for using advanced technologies in other professions? Or is it only when all such goals are realized in combination that technology education practice is worthy of being called ‘good’? These are the sort of questions we hope to answer through this project, but one needs to have a hunch already when making the selection of practices to be reflected on. How about context-dependency: is it possible that we would consider a certain practice ‘poor’ in one situation, for instance with ample resources, but call the same practice ‘good’ in a different context in which the teacher was able to make the best out of a very limited amount of resources? All the questions have to make us modest in our claims about what we will accomplish with this book.

Fortunately, some work had been done already as far as practices in the USA are concerned. An effort had been made by the Technical Foundation of America to put together a collection of good practices by drawing from the experience of a select group of teacher educators and research in the USA. They had been asked to suggest examples of good practices in technology education, and the outcomes
have been published in the brochure ‘Exemplary Technology Education’, edited by Gene Martin and Christopher Martin. We have drawn from that collection when putting together the chapters in Part I of this book. But those are examples from the USA only. In order to get a more worldwide scope we have consulted colleagues in other countries of the world. Finally, the editors of this book used their own experience in the field. Thus we put together a collection of eight exemplary stories of good practices from a variety of countries: Australia, Colombia, India, the Netherlands, New Zealand, the UK, and the USA. Clearly, this does not cover the whole world. But at least we have examples from countries with a long tradition in technology education (e.g., the UK) and relative newcomers in the field (e.g., India), countries in which teachers can work with ample resources (e.g., USA) and situations where one has to be very creative to work with the few resources that are available (e.g., Colombia), countries in which technology education is supported by educational research (New Zealand) and countries where it is not (the Netherlands), countries where technology education is compulsory for at least one level of schooling (Australia) and countries where it is only taught as an elective subject or as part of another subject (India).

In our selection we have also tried to get a certain variety in technological contents. As a result we have examples from biotechnology, city planning and construction, electrical engineering and electronics, industrial archeology, mechanical tools and artifacts, power and energy, and textiles. These represent both high tech and low tech topics. Still, we realize that there remains much to be desired with respect to this selection. But we did not aim for complete coverage, not for a representative sample. The idea was to explore the possibilities of reflecting on what at least some experts consider to be good practice in order to gain insights into what makes good practice to be called ‘good’.

Finally, we have different levels of education represented in our sample: primary education, junior and senior secondary (general and vocational), and teacher education.

THEMES FOR REFLECTION

The next question in our project was to identify relevant issues for reflections. When making a survey of topics about which research articles had been published in 10 volumes of the International Journal of Technology and Design Education (de Vries 2003), for which I currently serve as the editor-in-chief, I have found the following categorization useful. A first group of topics deals with the content of technology education. A second group of topics focuses on the people who teach (or determine what is taught) and those who learn. A third group of topics concerns the educational strategies and means that are used by teachers to make learners learn the desired contents in technology education. For each of these three categories one could draw up an endless list of relevant sub-topics, but here again we were faced with limitations for our project. So here, too, the readers should not judge the outcomes for completeness, but rather see this book as a first effort to see
what reflections on exemplary practice from a number of different angles of view lead to.

In the realm of content for technology education, the following topics have been selected: technological literacy, ethical aspects of technology, cultural aspects of technology, and design as a key activity in technology. Technological literacy is a term that is used to point out that people need to have a good understanding of what technology is in order to be able to live in a technological world. Therefore learning concepts of and in technology is a crucial element in technological literacy. As technology is very much a matter of decision making, values play a vital role in technology. This is why ethics should be an integral part of every technology education curriculum. Technology is related to the culture in which it is developed. So a good understanding of technology must also comprise an insight into the cultural aspects of a technology. Finally, design is generally seen as perhaps the most characteristic process of technology. Technology is bringing about new products and the way through which they come about is through design activities.

As far as topics related to the people who are involved in technology education, the first question that rises is: who are they? In other words: who are the stakeholders in this school subject? The next question is: what properties do they have. In current technology education research, there is much interest in their attitudes and in motivational aspects.

Finally there is the category of strategies and means. Here we pay attention to teaching strategies, to social aspects of learning, and to assessment. All three are topics that have been the focus of several studies in educational research for technology education.

Together the three categories offer an impression of the variety of educational topics that influence our view on what is good practice. Here too, I want to emphasize that the list is by no means exhaustive. In my survey of researched topics in the International Journal of Technology and Design Education, all the chosen topics feature prominently. In that respect the selection represents some of the most relevant topics in technology education research.

STRUCTURE AND CONTENT OF THE BOOK

The considerations sketched above have led to the following structure of this book. Part I contains all teachers’ accounts. We have asked the teachers to tell the story of their practice as concrete as possible in order to give a clear picture of what they had done in their classrooms. Part II contains the reflections on those practices from the different points of view as described in the previous section.

In Part I we have nine teacher accounts. Chapter 2 by Paula Wine and Judy Moreland is about making fermented drinks in primary technology education. Biotechnology is an area where science and technology are closely related. This is reflected in the kind of measurements pupils perform in the lessons that are described. In primary education in general school subjects are dealt with in a more coherent way than in secondary education. Often it is one teacher who teaches it
all. This way of teaching is ‘natural’ in that it connects with the way we experience reality, namely as a whole, and not split up in a scientific, a technological, and other parts. Analyzing reality by separating the various aspects of reality, which certainly has its merits, can wait until secondary education. Wine’s lessons also have a social dimension. Pupils learn to reflect about what a specific target group would want. It is interesting to see how the international dimension in the activity: pupils started by looking at traditional drinks in different countries. No doubt this must have appealed to a class with such an amazing diversity of countries represented (apart from New Zealand also Korea, Iraq, Zimbabwe, Thailand and Afghanistan). Chapter 3, by Diane Novak and Patrick Foster, also has a multicultural setting. The elementary pupils in Novak’s project were given the assignment to plan, design and build a three-dimensional model of a multicultural living community. There are several interesting aspects in this activity, apart from the multicultural aspect. The project connects several technological domains: transportation, construction, and communication. As in Wine’s lessons we find both research and development activities in the project. Another interesting feature of the project is the involvement of external, real experts. Education in general always struggles with finding a compromise between the full complexity of reality and a version of reality that is simplified, but without being unrealistic. It seems that Novak succeeded in striking a good balance in this respect.

Chapter 4 takes us to the first year of junior secondary education. The multidisciplinary character of technological activities is still present in Kenneth Pryde’s industrial archeology project. Pupils learn to study the New Lanark Mills from different disciplinary perspectives. They learn to appreciate that each of these perspectives adds in its own unique way to our understanding of the situation. In that respect Pryde’s project helps pupils to make the step from a comprehensive view on reality to one that is enriched by contributions from different perspectives. Pryde’s project also nicely illustrates how historical projects certainly need not be boring paper-and-pencil activities. In Pryde’s project also practical activities (designing and making) are included.

Chapters 5 and 6 are situated in senior secondary education. Tony Cox’s chapter illustrates how electronics can be used as a vehicle for design and make activities. This chapter also illustrates the way animations and modeling can be combined with the construction of devices. Here, too, we find elements of other subjects, math and science in the technology lessons. Creativity and fun also feature in the Robobug project that is described in this chapter. The conditions under which Escobar had to work on his three-phase motor were quite different from Cox’s conditions. In Chapter 6 Luis Bernardo Rios Escobar describes the situation in Colombian schools. His industrial technical school does not have all the nice facilities that were available in Cox’s school. Yet, Escobar was able to develop a challenging activity for his students. The chapter shows how good educational strategies can do a lot to compensate for poor conditions. Realizing learning goals in technology education does not always require the availability of high tech labs.
In Chapter 7 we are at the level of teacher education. Josine Frederik and Wim Sonneveld describe a project in which teachers analyze artifacts they are not familiar with. The challenge is to reason from physical characteristics of the object to functionality. This activity helps teachers to grasp the concept of the two ways in which artifacts can be conceptualized: the physical and the functional description. The fact that the artifacts are unknown to teachers of course also adds an element of curiosity, which contributes to the fun of the activity. This is then connected to the design process in which the relations between the physical and functional dimension of the artifact are again at stake, but then in the opposite direction: designers have to reason from desired functions to realizable physical properties.

We have no cases in higher engineering education. Chapter 8 takes us back to the level of high school, but there is a relationship with engineering education in that the teacher has an engineering background. Thelma Kastl, the author of the chapter, was a metal machinist and an electronics engineer before moving into education. She holds an electronics degree, a pharmacist technician’s degree and a technology education degree. This makes her a very valuable role model in technology education. Not many professional engineers end up with a career in education. For the technology education profession this is truly a pity, as it does make a difference whether one knows the engineering practice ‘from inside’ or not. As in Cox’s chapter we find a combination of animation and construction in the activities that are described by Kastl. The element of fun that we found, e.g., in Frederik’s and Sonneveld’s chapter also features here: Kastl used Rube Goldberg’s crazy machines as a source for her high school students to work with.

The element of fun and play is also an important element in the activities described by Swati Mehrotra and Ritesh Khunyakari in Chapter 9. Although the activities take place in primary school, the project is part of a research project carried out by the authors as part of their Ph.D. study. Therefore, this final account in our set illustrates the way educational research and curriculum development can be combined in a successful way. Puppetry and storytelling are very attractive as a context for a technology project in primary education. Mehrotra and Khunyakari show how such an activity can contribute substantially to the development of the pupils’ understanding of what technology is all about. As in Escobar’s chapter, the conditions for the activities were not a richly equipped high tech lab, but the authors clearly were able to exploit the available resources in an effective way.

All together these teachers’ account form a palette of different ways in which different circumstances and different strategies can lead to rich learning situations. The authors of Part II have tried to extract from these teachers’ accounts which aspects of their activities make them examples of good practice. In this Part we have ten chapters, each of which has been written from a particular perspective. The first four of these deal with the content of technology education.

In Chapter 10 John Dakers focuses on both the conceptual and the procedural dimension in technological literacy. John has recently published a book in which some well-known philosophers of technology wrote about their views on the content of technological literacy. Drawing from that book and other sources he
REFLECTING shows the importance of young people getting a good understanding of the nature of technology. In Dakers’ perspective, what makes good practice ‘good’ is the synthesis of different types of learning: procedural and conceptual, knowing how and knowing that, technological learning and learning about technology. It is this synthesis that should help pupils in developing an understanding of the nature of technology, as well as the ability that emerges from that to live and work in a technological world. Within this understanding of technology, ethical values take a particular place. This is what Rod Custer deals with in Chapter 11. Having first discussed the various ethical issues in technology at a general level, Custer shows that the teachers’ accounts contain more examples of potentials than of realizations. In this respect unfortunately our sample probably represents the current situation in technology education. Explicit attention for ethical issues in technology education projects may well be the exception rather than the rule at this moment. Yet, as Custer argues, it would be good if we would see the extent to which ethical questions are asked in technology education as one of the characteristics that determine what makes good practice ‘good’. Another issue in conceptualizing technology in technology education is technology’s cultural dimension. In Chapter 12, Chitra Natarajan spells out this dimension. Both technology and technology education reflect all sorts of implicit culturally determined values, and it would be good if such values are made explicit and understood. The author shows how this is the case also in the various teachers’ accounts in Part I. In her conclusions Natarajan claims that dealing with cultural diversity and with differences between the home and school cultures in a sensitive way is one of the factors that contribute to the ‘goodness’ of good technology education practice, because it promotes diversity and minimizes stratification. The last aspect related to developing an understanding of the nature of technology is the design aspect. Robert McCormick in Chapter 13 shows how ‘design’ is considered in different ways in the various teachers’ account. McCormick claims that it is the extent to which teachers are able to avoid pupils getting the impression that there is one unique ‘standard’ procedure for design is what makes good practice ‘good’. Pupils should experience how different design problems need different approaches. This gives design its particular challenge and makes it much more attractive than learning a routine.

The next three chapters focus on aspects of the people involved in technology education. Chapter 14 starts by showing who these people are. John Williams describes the various stakeholders in technology education. Then he shows why a stakeholder perspective is so important for a good technology education practice. ‘Good’ practice is that practice in which the interests of all relevant stakeholders have been taken into account effectively. Stakeholders have attitudes, and this is what Ken Volk deals with in Chapter 15. Most attitude research for education focuses on pupils and teachers. Attitudes are influenced by many things, and one of the aims of technology education is to have an impact on pupils’ attitudes towards technology. Volk shows how the teachers’ accounts indicate different strategies for accomplishing that: making the problems as realistic as possible, making students work in groups, being an understanding and passionate teacher, creating
interdisciplinary and energizing learning environments. Closely related to attitudes are the motivational aspects that are the focus of Ann Marie Hill’s Chapter 16. Hill indicates how different motivational theories are reflected in the various teachers’ account. Hill concludes by stating that ‘good’ practice from a motivational point of view actively engages pupils and students in authentic learning.

The last four chapters in Part II deal with strategies for making the learners learn what is valued in the educational goals. Chapter 17 by Judy Moreland and Bronwen Cowie opens this Part with an overview of teaching strategies. They are in agreement with Dakers (Chapter 10) when claiming that good practice means bringing together conceptual and procedural learning, and the social and technical aspects of technology. This requires teaching strategies that enable pupils and students to recognize continuity and coherence in the consecutive projects and activities they do. Defining macro tasks first and from that deriving meso and micro tasks stimulates that. Also the authors claim that multimodal strategies are needed to accomplish coherent learning. As already mentioned by Hill (Chapter 16), cooperation between pupils is important for establishing good practice. This is the focus of Chapter 18 by Michael de Miranda. The author further narrows this down by describing the way new media such as the Internet can support and enrich this. The idea of learning communities is mentioned frequently in current educational debates. De Miranda shows how the Internet is not only a source of information for students and a virtual learning environment, but also a medium for cooperation. From De Miranda’s chapter we can conclude that ‘good’ practice means making appropriate use of the potentials of new media such as the Internet to stimulate new ways of cooperation between pupils and students. In Chapter 19 Marie Hoepfl discusses the need to deal with differences between pupils in a class. These differences can be in many characteristics of the pupils: gender, economic and cultural background, language, physical (dis-)abilities, intellectual (dis-)abilities, etcetera. Good educational practice will do justice to such differences. Finally there is assessment as essential an element in good practice (already mentioned in Hoepfl’s chapter). In Chapter 20 Richard Kimbell describes different types of assessment in the teachers’ accounts. According to the author, teachers need to be aware of the ubiquity of assessment in their educational practice in order to deal with it properly and consciously.

FINAL REMARKS

In summary, the analyses of the Part I teachers’ accounts, as described by the experts in Part II, suggest the following characteristics of good practice:

1. as far as the content of technology education is concerned
   a. the synthesis of different content dimensions: procedural and conceptual, knowing how and knowing that, technological learning and learning about technology;
   b. the extent to which value questions are dealt with explicitly;
   c. dealing with cultural diversity and with differences between the home and school cultures in a sensitive way;

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d. making pupils acquainted with the fact that different design
problems require different strategies;
2. as far as the people involved are concerned
   a. dealing effectively with the interests of the relevant stakeholders
      in technology education (pupils, teachers, school boards, industry, etcetera);
   b. influencing attitudes by making the problems as realistic as possible, making students work in groups, being an understanding and passionate teacher, creating interdisciplinary and energizing learning environments;
   c. stimulating motivation by actively engaging pupils and students in authentic learning;
3. as far as education settings and strategies are concerned
   a. using multimodal strategies to enable pupils and students to recognize continuity and coherence in the consecutive projects and activities they do;
   b. making appropriate use of the potentials of new media such as the Internet to stimulate new ways of cooperation between pupils and students;
   c. dealing effectively with differences between pupils in a class such as differences in gender, economic and cultural background, language, physical (dis-)abilities, and intellectual (dis-)abilities;
   d. using a variety of assessment modes in an explicit and conscious way.

It can hardly be stated often enough that the aim of our analyses was not to be complete. But what the analyses do offer is evidence for the claim that reflecting on examples of good practice helps us understanding what we mean by ‘good’ practice and how it can be developed. The analyses in Part II made use of empirical studies, and in that sense they also give evidence for the claim that analyzing good practices alone will not be a sufficient basis for establishing what makes good practice. Technology education research should be a back and forth movement between empirical studies and theoretical analyses on exemplary teaching. Empirical studies can suggest variables that determine how good practice is, and vice versa analyzing good practice can help in setting up an agenda for empirical studies that relates to what really goes on in classes. This combination of two types of studies is necessary to get technology education on a higher level. The importance of technology as a factor in our contemporary culture and society most certainly justifies all the efforts that we put into that.

REFERENCES


Marc J. de Vries
*Eindhoven University of Technology*
*The Netherlands*
PART I
ACCOUNTS BY TEACHERS
2. TEACHING BIOTECHNOLOGY

Traditional Fermented Drinks

INTRODUCTION

Biotechnology may be defined as encompassing the use of living systems, organisms, or parts of organisms to manipulate natural processes in order to develop products, systems and environments to benefit people. Biotechnological products can include foods (e.g. cheese, yoghurt, milk drinks, ice-cream), pharmaceuticals and compost. Biotechnological systems include waste management, water purification, brewing, and antibiotic production. Biotechnological environments include hydroponics and organic farming. So biotechnology has scientific, technological and social dimensions. This interdisciplinary nature of biotechnology poses challenges for teachers. Many biotechnology topics are too difficult, or too theoretical, for students. As well, not many teachers have had experiences in teaching biotechnology to younger students, so exemplars of good practice are sparse. A concern in this traditional fermented drinks unit was how to assist students to synthesize the science ideas underpinning the biotechnology task with the technology ideas underpinning the hands-on development of a consumer-focused product. For example, scientific understandings about yeast as living would require integration with practical action, issues of health and safety, and ideas related to consumer preferences.

This chapter is about a class of 32 Year 8 (11 and 12 year old) students and their teacher undertaking their first biotechnology unit. The class consisted of 14 boys and 18 girls. Twenty-six students were pakeha New Zealand (NZ), two Korean (one of which was ESOL), one Iraqi, one Zimbabwean, one Thai and one Afghani. The classroom was like many NZ classrooms with a large area free of student desks that was used for group work and class discussions. Desks were arranged around the rest of the room in groups of 3 to 6. It was a colourful classroom with student work on show and there was a strong science-mathematics emphasis in the wall displays and interest corners.

PLANNING FOR THE UNIT

There were several reasons for choosing the development of a fermented drink product as the topic for study. They included teacher knowledge of fermentation,
the biotechnology focus, student likelihood of connecting with the topic, the hands-on nature, and the social dimensions of consumer testing. Additionally, making modifications to an existing drink would help students understand that technological activities often involve making adaptations and modifications to existing technologies and practices. The task was a ‘real life’ technological problem.

Planning was important for keeping the biotechnology focus strong and it helped with refining intended learning outcomes. Key questions that were kept in mind when planning were ‘How is this activity going to enhance students’ learning in biotechnology?’ and “What are the students learning?” The components of planning included a description of the task, the learning outcomes, the teaching sequence and the details for each lesson.

The task was for each group of three to six students to take a traditional fermented drink recipe and make adaptations to it. The traditional drinks included sima (from Finland), mint kvass (from Russia), root beer (from the USA), and ginger beer (from the UK). The adaptations were to be made in response to findings from people taste testing the traditional drink, science experiments investigating the effects of changes to the original recipe and a survey examining the flavours, textures, colour, and sweetness levels people like in fizzy drinks. A scenario was created to help give an overall direction for the task as well as create high student interest. This was the scenario:

You have found some recipes in your grandmother’s cupboard for traditional fermented soft drinks. There are some drinks you have never heard of! You decide to try out some recipes and find a few you really like. You wonder if any of these drinks could be produced and sold at school, even though “fizzy drinks” are not allowed. You think if you can modify some of the recipes to make them healthier your principal might allow these drinks. However, you know they also have to taste good or your friends won’t buy them.

Learning outcomes were grouped in conceptual, procedural and societal learning outcomes consistent with science and technology curricula. Conceptual learning outcomes related to understanding that yeast are living and can be manipulated and understanding fermentation. They included understanding: the significant components of the fermentation process; the factors that may adversely affect the outcome (i.e. Bacteria causing the drinks to go off) or be helpful to the outcome (i.e. Using cinnamon or acids such as lemon juice or cream of tartar to inhibit bacterial growth); a range of traditional fermented soft drinks; the steps of the adaptations made to the traditional recipe; how living organisms (yeast) can be used to produce a product (fermented drink); and, the components of the fermentation process that can be adapted. Procedural learning outcomes related to the procedures and processes to be undertaken and included: developing the specifications for their adapted traditional drink with justifications for the changes