Microworlds for Management Education and Learning

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Abstract

Computer-based simulations can be important tools to support learning. In this respect, so-called microworlds have been said to build substantial synergy between learning to think in systems frameworks and learning to deal with the complexity of actual settings. Since the first microworlds were introduced, their educational value has been accepted as an article of faith. In this paper the implications and results of adopting microworlds are explored in terms of student learning, educational approach and course design. These implications are illustrated with quantitative and qualitative questionnaire data obtained from courses in undergraduate Business programmes as well as post-experience MBA-programmes. In general, these data suggest that learning processes can be deepened and accelerated by creating effective combinations of lectures, cases, readings and microworlds.

Introduction

Recent developments in the area of business simulation create opportunities to build substantial synergy between learning to think in relevant theoretical frameworks and learning how to deal with the complexity of actual settings. Several so-called microworlds have been developed at the Sloan School of Management (MIT), London Business School and other universities and schools. Since microworlds were first introduced in higher education, their educational value has been accepted as an article of faith. Thus, there is no research that evaluates the process and outcomes of learning in the context of microworld simulations (Maier and Grössler, 2000). Also in view of Freeman and Capper's (2000) recommendations, this study evaluates the practical implications and learning outcomes of the adoption of microworlds as tools that may prepare undergraduate students for managerial work and deepen and accelerate learning by part-time MBA-students.

In this respect, the implementation of microworlds in several programmes for business education will be explored. The educational implications and outcomes of using microworlds are explored as follows. First, the microworld concept is defined and distinguished from other simulation tools, and illustrated with two microworlds: the mobile phone and professional services microworld. Subsequently, the implications of adopting microworlds for student learning, teaching approach and course design are described. These implications are explored in courses in pre-experience as well as post-experience programmes in which microworlds have been implemented.

Microworld as Learning Tool

Teaching and education in business and management is increasingly based on technological innovations in the area of multimedia and computer-based instruction (Alavi et al., 1997). One of these innovations is the so-called "microworld". The concept of a microworld was first defined by Papert (1980). Gradually, it has come to mean any simulation in which people can

participate by running experiments, testing different strategies, and building a better understanding of the aspects of the real word which the microworld depicts. Other words that have come into use are management flight simulators, business simulators and learning laboratories.

The idea of the microworld as a kind of flight simulator for managers and management students became well-known through Senge's *The Fifth Discipline* (1990). Senge argued that human beings learn best through firsthand experience, or 'learning by doing'. However, learning-by-doing only works so long as the feedback from one's actions is rapid and unambiguous. This leads to the so-called dilemma of learning from experience: one learns best from experience, but this learning only occurs if the consequences of important decisions and actions are experienced in an unambiguous and rapid manner (Senge, 1990). In order to deliberately and effectively create opportunities for experiential learning by management students, microworlds compress time and space. Thus, it becomes possible to experiment and to learn when the consequences of decisions and actions are in the future or in distant parts of the organization.

Microworlds are simulation tools for supporting learning about a business system, based on an explicit model of that business system. For example, the well-known *People Express* microworld is based on a model of the airline business. As such, microworlds can be distinguished from modelling-oriented simulation tools, such as Vensim, Powersim and Ithink, which can help users to understand the principles of a certain system by actively modelling this system themselves. The usefulness and efficacy of both microworlds and modelling-oriented simulations are virtually undoubted within the system dynamics community, but have not been systematically investigated (Maier and Grössler, 2000).

This study focuses on microworlds and in particular on the usefulness of two microworlds: the *Mobile Phone Subscriber Microworld* and the *Professional Services Microworld*. A short overview of both microworlds is given in Box 1.

Box 1: Overview of two microworlds

Mobile Phone Subscriber Microworld

This microworld focuses on the work of the Marketing and Customer Services (MCS) Director of a mobile phone company. The director has to build the customer-base of subscribers as rapidly as possible, and to ensure this growth is matched by increases in the capacity of the network to meet demand placed on it. Responsibility for the network capacity lies with the Operations Director, who is assumed to to do his job well by providing the capacity asked for by the director of MCS.

The system managed by the MCS director can be summarized in terms of the inflow, current number and outflow of subscribers, and the service capacity. It shows how the inflow of new subscribers is determined by marketing investments and word-of-mouth effects. The outflow of subscribers is a result of the 'churn rate', referring to subscribers terminating their contracts to switch to other mobile phone companies or to give up their mobile phone. In addition, subscribers may terminate their contracts as a result of poor service caused by lack of capacity (e.g., call failures, loss of signal). This poor service drives up the churn rate. Service capacity itself is determined by decisions to invest in new capacity, which subsequently comes available after six months. The simulation involves a period of five years, in which decisions on marketing investments and the desired capacity change (in six months) are taken, normally on a monthly basis. Depending on the purpose for which the microworld is used, participants can set different initial conditions (e.g. initial size, word-of-mouth growth rate) or other parameters (e.g. time period: 1 month, 3 months, 1 year).

When using the microworld, participants can ask for different types of information on the computer screen: reports, graphs and tables. The information given can be on revenues, costs and profits (e.g. total or per subscriber), net or cumulative cash flow, actual and target service capacity, gained and lost subscribers, and so forth.

This microworld does not provide a comprehesive view of the mobile phone business, but focuses on a simplified set of issues around growth in the customer base and the network capacity. It is especially useful for introductory courses in the area of, for example, Business Studies, Services Management, Strategic Management or Systems Thinking. The software can be easily installed on any computer system.

Professional Services Microworld

This microworld illustrates the issues faced by firms in sectors such as advertising, accountancy, law and consulting. It is particularly inspired by the development of the strategy consulting firm McKinsey &

Company. This microworld provides the experience of managing and developing a professional staff group across several levels of seniority (consultants, managers and partners) and the building, development and retention of a client group who provide work engagements and thus cash flow. Key issues in using this microworld are, first, the need to assure high quality of work for clients in order to build a reputation that will ensure future growth, and second, the financial and motivational incentives to keep staff busy and challenged in order to create the financial surplus that rewards top professionals.

Participants in this microworld take the role of the team of senior partners of a strategy consulting firm, starting in the year 2000, with the assignment to grow the business in size and reputation over the following 30 years. This means they have to (learn to) understand and manage the complex interplay between tangibles such as staff at different levels, number of clients and cash flow, and intangibles such as reputation, experience, knowledge base, quality of work and promotion prospects. The simulation can be used on different levels of complexity (e.g., with or without a knowledge base) and also entails a large number of extra facilities, such as several pre-installed scenarios illustrating a specific situation. In managing their consulting firm, the partner team can find and analyze data in the area of clients, quality, reputation, staff, workload, funds and knowledge in the form of written reports, graphs or tables.

This microworld involves a comprehesive simulation of the strategic aspects of running a professional services business. It is particularly useful in more advanced courses in Services Management, Strategic Management or Systems Thinking. The software can be easily installed on any computer system.

Source: *User Guides* for Mobile Phone and Professional Services Microworld, Global Strategy Dynamics Ltd., London, 2000.

Educational Objectives

The main objective for using microworlds as an educational tool is to motivate and facilitate students towards deeper and more integrated understanding. In this respect, a well-known distinction in the literature on student learning is between the surface and deep approach to learning (Reynolds, 1997; Sadler-Smith, 2001). The *surface* approach is tied to what is given in a specific learning situation, for example, a text, problem or assignment (Martin, 1999). The focus is on providing an answer in terms of the specific instance. Students adopting this approach are satisfied with memorising isolated facts, concepts or ideas (Freeman and Capper, 2000).

A *deep* approach to learning goes beyond the given situation or problem, and explores the larger issues represented by a particular problem (Martin, 1999). This approach arises from one (or a combination) of the following conceptions:

- learning as understanding, making sense or abstracting meaning;
- learning as interpreting and understanding something in a different way, that is, by reinterpreting knowledge;
- learning as changing as a person; here, learning involves not just seeing the world differently but seeing one's own position in the world differently (Martin, 1999).

A common misunderstanding of the deep and surface distinction, particularly among teachers, is that the approach adopted by students is seen as a characteristic of the students themselves. However, students have been observed to adopt different approaches in different circumstances (e.g., Kember and Harper, 1987; Richardson, 2000; Vermunt, 1998).

Microworlds are more likely to be productive and valuable in the context of deep learning than for surface learning. The complex interplay of variables and forces in microworld simulations may challenge students to make sense of a certain problem in its wider setting. Moreover, strategies that do not seem to work challenge students to explore changes in their mental maps and theories. The integrated systems perspective incorporated in microworlds

may also lead students to rethink their own professional expectations, ambitions and career plans.

Educational Implications

In order to achieve deep learning outcomes by adopting microworlds in a given course, several other conditions on the level of course design and teaching approach are required (cf. Ramsden, 1992). First, the emphasis should be on teaching and assessment methods that foster active and long-term engagement with learning tasks, rather than methods emphasizing recall or the application of trivial knowledge. Second, frequent feedback on (lack of) progress is probably an important condition for learning from work on a microworld.

In general, microworlds can be adopted and implemented as an add-on to the current, preferably deep, approach used by the teacher in question. If the previously existing approach focuses on case studies, the microworld can be introduced into the course as a case study supported by computer simulation. As such, the microworld creates opportunities to experience the dynamics of key strategic issues found in a real business case situation. If the existing approach is more based on lectures and readings, microworlds can be implemented in order to increase opportunities for experiential learning.

Depending on personal preferences and other conditions – such as the size of the student group and the availability of computer facilities – simulations on the microworld can be done under supervision in the classroom or without supervision on computers selected by the students. In the latter case, a more structured process of delivering reports and subsequent feedback in follow-up sessions will be necessary. Students can work alone on simulation assignments, but they can also work in teams when teamwork is considered to be important

(in view of the objectives of the course and/or programme). In general, microworlds appear to be quite flexible tools that can be easily incorporated in existing course designs.

For educators who are not familiar with microworlds, a significant initial investment in time is needed. This initial investment particularly concerns the first microworld adopted, because in that case one has to explore and try out the software as a new educational tool. In most microworlds the system dynamics language – in terms of stock and flow diagrams and feedback structures with delays – is used. Although these microworlds can be adopted and used without a background in this area, there is an evident synergy between systems thinking and microworlds as educational tool.

Microworlds in Undergraduate and Postgraduate Courses

The implications of adopting microworlds can be illustrated with data from three courses, two at the undergraduate level and the other in a post-experience MBA-programme. First, the Mobile Phone microworld was used in *Introduction to Business Studies*, an introductory course in the first year of the undergraduate Business Studies programme at Tilburg University. The main objective of this course is to build awareness and understanding of the dynamics, complexity and variety of the business world. The course exposes students to a large number of critical issues, such as different options for organizing business, managerial decision making, communication, marketing, operations management, finance and accounting, and business ethics. Furthermore, this course explores the changing environment of business and the implications for organizations and their management. By way of a combination of lectures, assignment work in teams (of 4 or 5 students) and individual self-study, a basic understanding of the interdependencies and interactions between decision-making, marketing, operations, and so forth, is developed. The Mobile Phone microworld is used in the last two weeks of this course to create opportunities for experiencing these complex interdependencies. Students downloaded the software from one

of the university's computer servers on local computers in the campus area, or via internet from a website specifically designed for this purpose on their own computers. On the basis of a user guide and two assignments, each team worked on the microworld in its own pace. Feedback was given in plenary sessions in which all students participated and by means of questions and answers processed by means of the digital learning environment created for this course.

Microworlds were also used in an elective course on *Management and Organization* in the third year of the undergraduate Business Economics programme at Tilburg University. This course explores a number of recent issues in the area of services management, organizational learning, leadership and systems thinking. The course was largely based on readings, assignments, presentations by students, and short lectures by the teacher. Both the introductory Mobile Phone microworld and the more complex Professional Services microworld were adopted to illustrate systems thinking applied to (services) management. The Mobile Phone microworld was used early in the course, and the Professional Services microworld near the end. The simulation work was triggered by assignments outlined in the course manual: students were asked to work in small teams with the simulation software in order to create a certain outcome (e.g., 200 % growth in the number of subscriptions under certain financial restrictions, by at least two different scenarios) and make sense of their strategy, any unintended consequences and the outcomes. Students downloaded the software from the university's computer server on local computers in the campus area, or picked up a cd-rom in order to install the software on their own computers. For both microworlds a user guide was available. This mode of delivery was chosen because it is very flexible, providing students the opportunity to use the software in their own pace and to spent as much time on it as needed. Feedback was given in plenary sessions in which all students participated as well as through open office hours.

Finally, the *Strategic Management* course in an executive MBA-programme provided a somewhat different educational context for using microworlds. This programme emphasizes action learning by a combination of a limited amount of readings, cases, assignments regarding the participants' work settings, classroom discussion and feedback. About half of the participants in this programme come from professional services firms, and the other half comes from industrial companies and not-for-profit organizations. In this course, the Professional Services microworld provided students with the opportunity to learn to see patterns in the complex interaction between tangible and intangible resources in professional service firms (cf. Box 1), and explore strategies for dealing with these patterns. The participants prepared for the session by reading an introductory article on strategic resources and system dynamics. The software was installed to a number of notebook computers prior to the full-day session. The session was held in a seminar room with one computer connected to a screen visible for all participants and sufficient notebook computers for both individual and group work. This mode of delivery was chosen in view of time constraints, both in terms of teaching time and preparation time of participants. The time schedule of the full-day session was as follows:

1 hour:	Class introduction: strategic resources framework is outlined and discussed with participants. Brief demonstration of the software (last 15 minutes).
½ hour:	Individual work: participants work through the Tutorial on computers, with support from the instructor and a copy of the User Guide.
2 hours:	Group work I: participants work in small groups on first simulation assignment (focusing on management of tangible resources), setting strategic goals and running the simulation to achieve them.
½ hour:	Debrief I: discussion of group results and learning points.
1 hour:	Class discussion: additional resources relevant to professional services firms, especially intangibles such as morale, reputation and experience, are described and discussed.
2 hour:	Group work II: participants work in small groups on second simulation assignment (focusing on the interaction between tangibles and intangibles), setting strategic goals and running the simulation to achieve them.
1 hour:	Debrief II: discussion of group results. Discussion and summary of main learning points.

Learning Through Microworlds: Some Findings

The two courses described in the preceding section are evaluated by programme management on the basis of standard evaluation forms distributed among the participants at the end of the course.[1] The evaluation approach used by programme management was different in all cases and therefore not comparable. Moreover, these evaluations did not assess the value of microworld simulation tools, which were completely new to these programmes. Thus, a short evaluation form, involving thirteen closed and three open questions, was developed in order to explore the value and usefulness of microworld simulation.[2] In addition to several practical conditions (e.g. user guide, software), the feedback by the instructor and the nature of group dynamics in the respondent's team are addressed in this evaluation form. Feedback by the instructor as well as group dynamics can have a strong influence on learning and decision-making processes, and thus affect learning effectiveness (Maier and Grössler, 2000). With regard to group dynamics, three questions regarding the quality of team collaboration were taken from the Group Style Instrument developed by Watson et al. (1998).

This short evaluation form was handed out together with the standard evaluation form by programme management at the end of each course. The junior undergraduate course was taken by 171 students (number of respondents = 162). The senior undergraduate course was given two times, and was taken by a total number of 69 students (respondents = 63). The MBA-course was given three times (with 54 participants and respondents). Table 1 gives an overview of the descriptive statistics regarding the closed questions used in the evaluation. This table provides only descriptive statistics and not correlations because the latter would suggest a belief in simple cause-effect relationships (Forrester, 1961 and 1971; Sterman, 1989). The descriptive statistics in Table 1 are here used only to explore a number of important conditions and patterns.[3]

The results show that prior experience with microworld simulation was completely absent in the undergraduate courses and very low in the post-experience course. Table 1 also reports the perceptions of participants regarding a number of conditions: the quality of the software and user guide; coherence and usefulness of the theoretical framework outlined in readings and lectures; quality of the assignments; and the usefulness of the feedback given by the lecturer. These conditions were evaluated positively by the participants in all courses. In general, these conditions can together be viewed as a *conditio sine qua non* for effective use of microworlds. Marsick and O'Neil (1999) make a similar observation in the context of action learning.

The effectiveness of teamwork during the simulations – in terms of listening, making comments and exchanging ideas – is also a factor that may influence the learning process. Teamwork among the junior, and thus more immature, undergraduate population appeared to be substantially less effective than among the senior undergraduate and postgraduate students (see Table 1). This implies that particularly for the latter categories of students team collaboration tends to have posivitely reinforced the learning process and outcomes in both settings.

In view of the objective of this study – exploring the added value of microworlds as educational tool – the last three variables in Table 1 are important. The junior undergraduate students had recently completed secondary education and thus were without any previous experience in academia. These students perceive the added value for learning – in general as well as compared to previous education – to be somewhat lower than the senior students do. Both the senior undergraduate and postgraduate students evaluate the added value of the microworld tool as rather high, also relative to learning experiences in previous courses or when comparing it with experiences in the "real world".

Insert Table 1 about here

The answers to the *open questions* on the evaluation form illustrate these findings. Many undergraduate respondents describe learning outcomes that incorporate elements of both surface learning (e.g., applying, solving) and deep learning (e.g., understanding, experiencing). For example:

> "The microworld provides the opportunity to experience how it feels to manage and lead a business. Insights in system patterns obtained earlier can now be applied in the simulation."

Several undergraduate students emphasize deep rather than surface learning:

> " The mobile phone microworld was a good introduction which showed what the limits-to-growth archetype is all about. What struck me most in the professional services microworld was the fact that we had to deal with many unexpected things. You can only deal with unexpected events if you really understand how the relations between resources and strategy are."

Similar comments were made by two participants in the executive MBA-programme:

> "I particularly liked the set-up of the session around system dynamics and the resource-based framework. Frequently switching from short lecture to simulation assignment to discussion, to lecture and simulation again, and so forth is very effective. It keeps me very alert, it is very different from the normal seminar approach."
>
> "The simulations were an eye-opener for me. I now really understand the role of intangible resources such as reputation and experience, and how it is affected by marketing and strategy."

In the undergraduate course Introduction to Business Studies, each team of students wrote and delivered a report on the assignments that also included an assessment of what the

team had learned of the work on the microworld assignments. For example, one of the teams in the Introduction to Business Studies course wrote:

> “These are really diverse assignments. All components are linked with each other; therefore each decision has its influence on other processes within the company and this makes it interesting. We had to look ahead and think about the consequences of our actions and possible solutions before we could actually see the results. Because we tried a lot of options we found out different ways of running the company. Most of them were not very successful, but you still learn from that.”

Other teams in the same course emphasized a number of practical insights resulting from the work on the Mobile Phone microworld. For example, two typical excerpts are:

> “The insights we have obtained are as follows. We now realize the strong relations between the different departements. We understand the connection between the higher and lower spending subscribers; if you have too many subscribers compared to your service capacity, the higher spending subscribers will probably leave, because the service has to be spread out among more people. Another insight is that cash flow responds almost immediately to decisions, which leads to monthly fluctuations.”

> “Marketing is closely connected to operations, especially the capacity. There should be a sort of balance between investments in marketing and investments in capacity. It is not useful to invest large amounts of money in marketing if your capacity cannot cope with the new subscribers. After a short while the number of new subscribers per month will equal the number of leaving customers, because the undercapacity leads to negative word-of-mouth.”

Concluding Remarks

There is almost no research that evaluates learning processes in the context of microworld simulations (Maier and Grössler, 2000). Therefore, this paper explored the adoption of microworld simulations as educational tools that may prepare undergraduates for managerial work and deepen and accelerate learning by part-time MBA-students. The implications of adopting microworlds have been outlined, and subsequently data obtained in several courses have been presented and discussed. The findings suggest that, if a number of important facilities and resources are provided, students can be stimulated towards deeper learning by means of tailor-made combinations of lectures, cases, readings and microworlds. The educational value of this particular form of business simulation appears to arise from the rapid and straightforward feedback given in a microworld simulation and the systems frameworks used for reflection and understanding.

The findings in this study also suggest that the educational value of microworld is perceived to be greater by mature undergraduate and postgraduate students than by junior undergraduate students. Of course, this study is limited in the sense that it is exploratory in nature. Moreover, given the fact that microworlds were (almost) completely new tools for the undergraduate and postgraduate students in this study, the findings may have been biased as a result of enthusiasm arising when people can play around with new technology. Future research will also have to look at the learning outcomes in student populations who are already familiar with microworlds.

Endnotes

[1] The overall rating of all classes/courses was above the average rating of courses in the same programmes.
[2] This form is available upon request from the author.
[3] The matrix with intercorrelations between variables showed that most variables are not independent of each other. This matrix is available upon request from the author.

References

Alavi, M., Y. Yoo and D.R. Vogel (1997), "Using information technology to add value to management education", *Academy of Management Journal*, 40, 1310-1333.

Forrester, J.W. (1961), *Industrial Dynamics*, Cambridge, MIT Press.

Forrester, J.W. (1971), "Counterintuitive behavior of social systems", *Technology Review*, 73 (3), 52-68.

Freeman, M.A. and J.M. Capper (2000), "Obstacles and opportunities for technological innovation in business teaching and learning", *International Journal of Management Education*, 1, 37-47.

Kember, D. and G. Harper (1987), "Implications for instruction arising from the relationship between approaches to studying and academic outcomes", *Instructional Science*, 16, 35-46.

Leidner, D.E. and S.L. Jarvenpaa (1993), "The information age confronts education: Case studies on electronic classrooms", *Information Systems Research*, 4, 24-54.

Maier, F.H. and A. Grössler (2000), "What are we talking about? – A taxonomy of computer simulations to support learning", *System Dynamics Review*, 16, 135-148.

Marsick, V.J. and J. O'Neil (1999), "The many faces of action learning", *Management Learning*, 30, 159-176.

Martin, E. (1999), *Changing Academic Work*, Buckingham, Open University Press.

Martin, E. and M. Balla (1991), "Conceptions of teaching and implications for learning", *Research and Development in Higher Education*, 13, 298-304.

Papert, S. (1980), *Mindstorms: Children, Computers, and Powerful Ideas*, New York, Basic Books.

Ramsden, P. (1992), *Learning to Teach in Higher Education*, London, Routledge.

Reynolds, M. (1997), "Learning styles: A critique", *Management Learning*, 28, 115-133.

Richardson, J.T.E. (2000), *Researching Student Learning: Approaches to Studying in Campus-based and Distance Education*, Buckingham, Society for Research into Higher Education & Open University Press.

Sadler-Smith (2001), “A reply to Reynolds’s critique of learning style”, *Management Learning*, 32, 291-304.

Senge, P.M. (1990), *The Fifth Discipline: The Art and Practice of the Learning Organization*, New York, Doubleday.

Senge, P.M., A. Kleiner, C. Roberts, R.B. Ross and B.J. Smith (1996), *The Fifth Discipline Fieldbook*, London, Nicholas Brealey.

Sterman, J.D. (1989), “Modeling managerial behavior: Misperceptions of feedback in a dynamic decision-making experiment”, *Management Science*, 35 (3), 321-339.

Vermunt, J.D. (1998), “The regulation of constructive learning processes”, *British Journal of Educational Psychology*, 68, 149-171.

Watson, W.E., L. Johnson and D. Merrit (1998), “Team orientation, self orientation, and diversity in task groups: Their connection to team performance over time”, *Group & Organization Management*, 23 (2), 161-188.

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