Investigating Economic Classroom Experiments

How Economic Classroom Experiments Can Support the Economic Literacy of Students in Secondary Education
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Roel Grol

Nijmegen, December 2015
CHAPTER 1
CHAPTER 1

GENERAL INTRODUCTION

“We would not teach students tennis only by having them watch Wimbledon and we should not expect our students to be able to do economics after watching us do it in our lectures”

(Salemi, 2005, p. 49)
1.1 ECONOMIC LITERACY

People seem to know little about economic matters (Hansen, Salemi, & Siegfried, 2002). Recent studies show that during the years preceding the economic crisis of 2008, many individuals reached economic decisions that turned out to be unbenevolent to themselves and to others. For example, Mian and Sufi (2009) report 2002 to 2005 to be a period in which income was negatively correlated with mortgage credit growth in the United States. This indicates that people who actually could not afford a particular mortgage successfully applied for one, often stimulated by the community reinvestment act. After having encountered setbacks in their everyday lives, however, these individuals are at the risk of facing foreclosure or personal bankruptcy. Another example is taken from a World Bank survey in 2012. This study reveals that even though consumer loans in Russia grew at a rate of 1,600% between 2003 and 2008 “only 41 percent of the [Russian] survey respondents understood how interest compounding worked and only 46 percent could answer a simple question about inflation” (Klapper, Lusardi, & Panos, 2012, p. 2).

Signals such as these raise awareness of the importance of increasing people’s understanding of economic matters, which is often referred to as “economic literacy”. In some publications, economic literacy has been portrayed as “the ability to identify economic problems, alternatives, costs, and benefits; analyze the incentives at work in economic situations; examine the consequences of changes in economic conditions and public policies; collect and organize economic evidence; and weigh costs against benefits” (Wisconsin Department of Public Instruction [WDPI], 2008, p.1). Others define economic literacy by using more general terms, such as the ability of people to recognize and use economic concepts and insights in their own daily lives (Salemi, 2005). Although the levels of detail vary, both depictions of economic literacy share three basic elements: people’s knowledge of economic concepts, their ability to set up economic reasoning, and the skill to transfer economic concepts.
across situations or contexts. These three components are central elements in the present thesis and will be elaborated hereafter. Doing so from within the context of secondary education seems important, as the secondary school level may be the last opportunity for students to attend formal economics education (e.g., Walstad & Soper, 1988).

Secondary school curricula, amongst others in the United Kingdom (Department for Education [DfE], 2014), the United States (Siegfried et al., 2010), the German Bundesland Hamburg (Stolze, 2011), and the Netherlands (Teulings et al., 2005), aim at developing student understanding of a range of economic concepts. Economic concepts can be considered the building blocks of economic theory (Vernooij, 2012). This makes knowledge of basic economic concepts the first component of economic literacy (Frank, 2002; Salemi, 2005). However, knowledge of the definition of an economic concept is only a first step towards identifying the relationship of this concept with other ones (Amagir, Kneppers, & Westenberg, 2013; Armento, 1987; Fagin, Halpern, Moses, & Vardi, 1995). The latter requires economic reasoning, which is the second aspect of economic literacy. Reasoning in secondary school economics often involves causality (e.g., DfE, 2014). Causality addresses the relationship between a certain cause and an associated effect (Jonassen & Iones, 2008). In this thesis, economic reasoning is limited to the skill of identifying which economic concepts are present in a specific situation, determining a linear-causal relationship between these concepts, and explaining the causal direction of this relationship.

In class, secondary school students encounter economic concepts and their interrelatedness in a limited variation of situations or contexts only, due to time restrictions. In real life, however, the students are likely to face these concepts in a wider array of contexts than they could have practised in school. This is why several secondary school curricula in economics aim at developing the ability of students “to use those [economic] concepts in a variety of different contexts” (DfE, 2014, p. 1; see also Teulings et al., 2005). The third
component of economic literacy in this thesis is *transfer*. Transfer can be described as the ability to apply certain knowledge and/or skills in new situations (Alexander & Murphy, 1999; Stark, Mandl, Gruber, & Renkl, 1999). Students may be guided towards recognizing and using economic concepts in a wide array of contexts through analogical reasoning (e.g., Gick & Holyoak, 1983). The latter involves the process of identifying and abstracting the similarities between sources (e.g., Holyoak & Koh, 1987).

### 1.2 TEACHING AND LEARNING ECONOMICS

Economics teachers in secondary education aim at guiding their students towards a basic level of economic literacy and at preparing them for their possible future attendance of economics education (e.g., Siegfried et al., 2010; Teulings et al., 2005). This section starts by illustrating dominant knowledge contents and teaching practices in contemporary curricula for secondary school economics. Then, the limitations of these approaches will be discussed. The section ends by deliberating alternatives for these approaches.

To begin with, the dominant content of the economic knowledge addressed in secondary education seems to have a neoclassical character. As an example, in the United States, the *Voluntary Content Standards in Economics* affirm clearly that secondary school economics curricula “reflect the view of a large majority of economists today in favor of a ‘neoclassical model’ of economic behavior” (Siegfried et al., 2010, p. vi). A neoclassical approach to economics appears prominent in other countries as well, such as in the United Kingdom (DfE, 2014). Central to neoclassical economics is a belief in the “holiness” of rationality, self-interest, and equilibrium (Colander, Holt, & Rosser, 2004). Rationality implies that people make optimal choices to achieve their goals, self-interest involves being concerned for one’s own benefits only, and equilibrium refers to the circumstances in which supply and demand are balanced. These assumptions allow for technical and “objective” economic analyses (Morgan
& Rutherford, 1998). Following this idea, neoclassical economists reduce the complexity of human behavior to a model in which a rational, fully informed, and self-interested *homo economicus* employs optimal choice behavior (Bruni & Sugden, 2007; Cartwright, 2011; Grol & Sent, 2015). By definition, such a model represents only part of real economic behavior and it does so in a simplified way (Boumans & Davis, 2010; Friedman, 1966; Guala, 2005b; Mäki, 2005; Morgan, 2005). However, *homo economicus* has seldom been seen walking down the local vegetable market, buying train tickets, or purchasing a new car. Hence, it can be argued that the use of neoclassical models and assumptions may be more valuable for reaching educational goals regarding the preparation of students for attending future courses in college economics, rather than to improve their basic economic literacy.

As textbooks in secondary education seem based on instruction and exercises, teaching practices in secondary school economics rely on teacher-led and top-down approaches (Becker & Watts, 2001; Wentworth, 1987). Teachers in economics often persist in using traditional, deductive standard lesson formats (Emerson & Taylor, 2004; Hansen et al., 2002; Ortmann, 2003). During class, after being instructed, students might be asked to recall and apply a relatively vast number of economic concepts, by interpreting and/or producing formulas, models, or graphs (Frank, 2002; Hansen et al., 2002; Hey, 2005). Box 1.1 provides an illustration of the content knowledge and the pedagogical approach that can be observed in many economics classes.
Box 1.1 Illustration of a Traditional Lesson in Economics

Wednesday afternoon. Economics class. The teacher stands in front of the whiteboard when the students arrive in the classroom. Twenty-four on average 15-years old students sit down at their designated seats. The teacher asks the students to grab their pens, pencils, notebooks, and calculators and to pay attention, for something important about the economic key concept market is about to be explained. Then the teacher starts talking:

“The day before yesterday we examined producer behavior. Producers supply goods and services. We concluded that a positive relationship exists between the price and the quantity supplied by the producers; the higher the price they can get, the higher the quantity they will supply.”

“Thereafter, we studied the negative relationship between price and the quantity demanded by consumers; the higher the price they have to pay, the lower the quantity they will demand.”

“Today we will integrate both of these concepts. Demand and supply meet at a market. We can model this by means of a graph: we will draw the demand curve (D) and the supply curve (S) in a coordinate system.”

Now the teacher draws a coordinate system and two curves on the whiteboard (see the figure below) and then elaborates:

“Please pay attention to the intercept of the lines. The equilibrium price can be read from the y-axis, the equilibrium quantity from the x-axis. The equilibrium is the situation in which supply equals demand.”

Meanwhile the teacher draws the dotted lines in the coordinate system.

Now, the teacher usually asks questions, such as:
- “Suppose the price is €1.00, what is the quantity demanded at this price?”
- “Suppose the price is €1.00, what is the quantity supplied at this price?”
- “Is there a shortage in demand or a shortage in supply at a price of €1.00?”
- “Please illustrate the latter graphically.”

After discussing questions such as these and the corresponding answers, the teacher would ask the students to draw another graph in their notebooks based on the new information with which they are provided, and to indicate and interpret the new equilibrium situation. And then the lesson ends.
The lesson depicted in Box 1.1 illustrates the neoclassical character of the content knowledge that is addressed. For example, the linearly shaped demand and supply curves and the market equilibrium at the intersection of the lines are a result of assumed rational choices employed by self-interested consumers and producers. Graphs such as these reflect the neoclassical assumptions of rationality, self-interest, and equilibrium. Students are asked to analyze this abstract model and to answer questions within a given and restricted economic situation. Furthermore, the example in Box 1.1 illustrates the top-down nature of the theoretical instruction, followed by a teacher-led check if and to which extent the economic concept of market equilibrium has made it to the minds of the students.

It has been argued that a student enrolled in this kind of passive teaching/learning activities is likely to mainly “memorize a few facts, diagrams, and policy recommendations and ten years later will be as untutored in economics as the day he entered the class” (Stigler, 1963, p. 657). Following this stance, the highest attainable goal is that students gain knowledge of some basic economic concepts only, which is the first aspect of economic literacy. This claim seems related to empirical results indicating that attending economics courses during secondary education does not significantly affect the economic knowledge of the public later on in life in comparison to a group of adults who never attended economics education at all (Walstad & Rebeck, 2002). With regard to economic reasoning, which is the second aspect of economic literacy, Welp, Dieteren, and Kneppers (2009) find that the overall ability of Dutch secondary students to set up this reasoning during their final examinations is rather limited despite having attended lessons in economics for at least two years. Finally, research by Kneppers (2007) indicates that the transfer of economic knowledge across contexts, which is the third aspect of economic literacy, is hard to achieve as well. Together, these findings and suggestions strengthen the proposition that students enrolled in economics education “can surely benefit from any opportunity that replaces lectures with active participation” (DeYoung, 1993, p. 348).
A fairly recent comparison of educational studies provides preliminary evidence in favor of the collaborative construction of knowledge over less active classroom activities (Chi, 2009). Active learning emphasizes the involvement of students in the teaching/learning process (Creemers, 2005). Attention to active teaching/learning methods has increased in the last decades (Prince, 2004), which may be attributed to the rise and documentation of constructivist learning theory. Constructivism is a theory that depicts how learning takes place from a psychological stance (Fosnot, 2005). The theory describes how students construct their knowledge based on their experiences during a process of assimilation and accommodation (e.g., Jardine, 2006). Assimilation takes place when the new experience is incorporated in the existing knowledge structures in the mind of the student, the so-called schemas. Accommodation, on the other hand, takes place when the freshly gained experience results in the adaptation of the existing schemas (Jardine, 2006). Hence, constructivist learning is centered around the concepts of reality as held by the students. Encountering new experiences actively and discussing these may result in advanced representations of reality (Fosnot, 2005). Instead of reproducing the knowledge of teachers and textbooks (cf. Dewey, 1938/1997; Herrington & Oliver, 2000), constructivism involves using student’s prior knowledge actively and letting the students gain experiences to help the students to build new representations of aspects of, in the upcoming chapters, economic reality.

Although constructivist pedagogies may vary from student engagement in a story told by the teacher to a student’s inquiry of a research hypothesis (e.g., University of Sydney [UoS], 2014), all approaches share the idea that students construct knowledge (inter)actively, based on their prior knowledge and meaningful experiences. Lodewijks (1993), for example, identifies several elements of which powerful constructivist teaching/learning environments should consist. One of these characteristics is that teaching/learning activities should be designed to actively engage students in a discovery learning process. Another key aspect is that a broad
range of teaching/learning activities should be designed to allow each student to identify and apply the basic concepts of a specific discipline in a wide array of realistic contexts. As the construction of knowledge may also involve a social process in which students collaboratively discover the concepts and principles of a discipline (Vygotsky, 1978), teachers should not only create a classroom setting in which students can gain experiences by discovering aspects of reality, but also allow students to elaborate these experiences and findings through constructive dialogues with their classmates (e.g., Alexander, 2004; Dewey, 1938/1997; Mercer, 1995; Wenger, 1988).

Educational designs based on constructivist learning and instruction principles can be witnessed in classrooms worldwide. Well-known examples are experiential learning and inquiry learning. Experiential learning is aimed at learning by doing (Dewey, 1938/1997). In line with the previously described process of assimilation and accommodation, the experiences encountered by students during classroom activities are connected to their prior knowledge and experiences. Guiding students towards reflection on their learning experiences is important to achieve this so-called *continuity of experience* (Dewey, 1938/1997). How students can gain experiences and elaborate their schemas may be illustrated by means of the following example. Instead of reading a book on communication theory, students could be asked to visit a department store and observe how the employee at the customer care department communicates with a dissatisfied customer. These observations can be input for a classroom dialogue on client communication. Finally, each individual student could be asked to formulate and write down directions in a letter of advice to train junior customer care employees. As previous research shows that students find it hard to share their observations and viewpoints constructively with each other, communication rules provided to the students could support their collaborative exchange of experiences and ideas (Mercer, 1995; Wegerif, Mercer, & Dawes, 1999; Wegerif, 2001). Experiential learning allows students to gain personal
experiences through their own observations of and interactions with real world elements. In turn, these observations and interactions may help students to ask meaningful questions, to share and elaborate their ideas with their fellow students, and to formulate and/or extend their own representations (cf. Fosnot, 2005).

Another pedagogy that sprang from constructivist learning theory is inquiry learning. Students enrolled in inquiry learning are engaged in a scientific discovery process (e.g., De Jong, Linn, & Zacharia, 2013; Lazonder, Hagemans, & De Jong, 2010; Löhner, Van Joolingen, Savelsbergh, & Van Hout-Wolters, 2005; Zion, Michalsky, & Mevarech, 2005). Students formulate hypotheses, observe or design a scientific experiment, analyze data, reformulate their initial ideas, and discuss their findings together (Kuhn, Black, Keselman, & Kaplan, 2000; Lewis & Williams, 1994). Given the experimental nature of disciplines such as physics and chemistry, inquiry learning is prominent in science education (e.g., Osborne, 2010). Inquiry approaches to the teaching and learning of science often bring experiments into the classroom (Kuhn et al., 2000). With the help of these experiments, students are induced to formulate, test, and reflect on their initial beliefs regarding a specific situation. Previous research on inquiry learning processes in science education shows, amongst others, that students find it hard to formulate their own hypotheses (e.g., Gijlers & De Jong, 2009). Hence, supporting (meta)cognitive learning processes and student collaboration is considered helpful for structuring and performing the inquiry-based teaching/learning tasks at hand (e.g., Van Joolingen & De Jong, 1991; Van Joolingen & De Jong, 1997).

Active approaches to teaching and learning emerging from constructivist learning and instruction theories may also be used to increase the economic literacy of students. Two reports underlying the recently renewed examination standards in the Netherlands, for instance, elaborate the view that economics in secondary education should not only be listened to or read about, but should also be practiced and experienced by its students (Teulings et al., 2002;
Teulings et al., 2005). Although most western curriculum standards seem to refrain from prescribing particular teaching/learning methods (e.g., Siegfried et al., 2010; Stolze, 2011), the renewed curriculum standards in economics in the Netherlands explicitly require teachers to make use of active teaching/learning methods and mention the use of experiments as an important means for doing so (Centrale Examencommissie Vaststelling Toetsopgaven [CEVO], 2007; Teulings et al., 2005). These so-called economic classroom experiments can be defined as controlled interactive teaching/learning exercises targeting the comprehension of economics in an inductive way (e.g., Balkenborg & Kaplan, 2011; Ball, 1998; Becker & Watts, 1995; Croson, 2002; Holt, 1999; Walker, 1987; Wells, 1991; Williams, 1993). Moreover, economic classroom experiments may provide a means for reaching another important curriculum objective, namely engaging students in “an enquiring, critical and thoughtful approach to the study of economics” that will help them to develop “an ability to think as an economist” (DfE, 2014, p. 1). Economic classroom experiments not only provide a basis for teaching and learning economics in a less top-down way, but these may also offer opportunities for the students to gain personal experiences while learning by inquiry. Before exploring the main design characteristics of economic classroom experiments within educational contexts, the next section starts by examining their historical roots.

1.3 EXPERIMENTS IN ECONOMICS AND IN THE CLASSROOM

As economic classroom experiments originate in economics as a science (e.g., Haus, 2009; McKinnon, 1996), the present section provides a short history of the use of experiments in economics first. Although a large share of economists once seemed convinced that the economy could not be studied experimentally (e.g., Friedman, 1966; Samuelson & Nordhaus, 1985), the application of experiments in economics dates back over a century (Svorenčík, 2015). Early experiments have been used to determine microeconomic indifference curves4 (Thurstone,
1931), or to study market behavior (Chamberlin, 1948). It must be acknowledged that most of these early experiments were run by solitary researchers, were short of linkages with economic theory, and lacked a well-established experimental research tradition in economics (Svorenčík, 2015). Decades of research, however, have strengthened the methodological basis of economic experiments (Ball, 1998; Bergstrom, 2003; Camerer, Loewenstein, & Rabin, 2004; Croson & Gächter, 2010; Eckel, 2004; Guala, 2005a; Guala, 2005b; Guala & Salanti, 2001; Hertwig & Ortmann, 2001; Loewenstein, 1999; Sent, 2004; Smith, 1976; Smith, 1982; Smith, 1989; Smith, 1994; Smith, 2002; Svorenčík, 2015). Awarding Vernon Smith *The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel* in 2002 may be considered a general recognition of the use of experiments as an empirical research method in economics (The Royal Swedish Academy of Sciences [RSAS], 2002). The other winner of this prize in 2002 was Daniel Kahneman.

Economic experiments allow the empirical testing of research hypotheses in economics and are frequently used to study either market behavior or economic judgment and decision making (Loewenstein, 1999; Santos, 2011; Wells, 1991). Main goals of economic experiments can be regarded, amongst others, testing standard economic theory, establishing new economic theory, and opening up the dialogue between experimenters, theorists, and politicians (Kagel & Roth, 1995). Often, the research participants are recruited by the experimenters directly from the university campus or in the street (DeYoung, 1993). Mostly, these participants are randomly assigned to the research conditions (Santos, 2011). Before an economic experiment starts, all participants receive experimental instructions. These define the boundaries of the experiment and shape the behavior of the participants in each of the research conditions (Morgan, 2005; Starmer, 1999a; Starmer, 1999b). As stated by the induced value theory (Smith, 1976), the use of a proper reward medium provokes the participants in an economic experiment to employ the economic behavior desired (Smith, 1982; Friedman & Cassar, 2004). Hence, the experimental
instructions have to state clearly that the research participant will receive a performance-dependent, non-fixed reward when the experiment is over. These rewards should at least equal the opportunity costs of the participants\textsuperscript{5}. To be sure that the research participants prefer more reward to less, and to avoid satiation, economic experimentalists often use real monetary incentives (e.g., money) as performance-dependent payments (Boumans & Davis, 2010; Friedman & Cassar, 2004; Lee, 2004; Mäki, 2005; Smith, 1982; Starmer, 1999b). Finally, economists do not intend to deceive their research participants purposely, as may be the case in experiments in psychology (see Hertwig & Ortmann, 2001). Participants in economic experiments are assured that all instructions they are told are to be adhered to both by themselves and the experimenters (Cartwright, 2011). Together, these aspects allow for “a carefully planned and fully replicable observation of a phenomenon under controlled conditions” (Fiore, 2009, p. 5)\textsuperscript{6}, indicating a high degree of internal validity. This means that no other variables except the ones which are studied during the economic experiment cause the experimental results (Heukelom, 2009)\textsuperscript{7}.

Another aspect of economic experiments regards the use of a context. Mostly, economic laboratory experiments offer very few real-world details. Researchers refrain from providing too much context information, amongst others to prevent that the experimental behavior employed by the research participants is influenced by their familiarity with a specific real world situation, as well as possible emotions involved (e.g., Bernard & Bernard, 2005). Instead, economic experimentalists often choose to replicate a functional part of the real world in a laboratory environment (Croson & Gächter, 2010; Kagel & Roth, 1995; Mäki, 2005; Samuelson, 2005; Smith, 1994; Starmer, 1999a; Sugden, 2005). Hence, an experiment in economics “creates a simple and neutral context of interaction in which subjects guided by induced economic motives make fairly abstract decisions” (Santos, 2011, p. 47). However, a lack of context may cause dissimilarities between the experimental setting and the real world.
(Friedman & Cassar, 2004; Harrison, List, & Towe, 2007; Mäki, 2005; Siakantaris, 2000). This may result in a relatively low level of external validity, which means that results emerging from a controlled economic experiment may not be generalized or applied to real-world settings directly (e.g., Levitt & List, 2007). When the experiment is over, participants are paid in line with the reward structure that has been stated during the instructions. The participants will leave the experimental setting and might never interact with each other again. Hence, no explicit debriefing of the results with the participants is likely to take place (DeYoung, 1993; Friedman & Cassar, 2004). Finally, the researchers will analyze the data that emerged during the experiment.

The experimental features described so far regard the general use of experiments as an empirical tool when studying, for example, economic behavior. Chamberlin (1948) ran his experiments to generate insights in market behavior with his students from Harvard University as research participants. However, his experiments comprised a pedagogical component as well. It has been witnessed that “[a]n unexpected spillover of using students as subjects in experiments was that they learned economic principles, often more effectively than in the traditional classroom” (McKinnon, 1996, p. 162). Similar to this observation, Menkhaus, Yakunina, Bastian, and Esipov (1997) suggest that the use of economic experiments during class may help students to gain understanding how markets work. It has been argued that the increased acceptance of experiments in economics has stimulated the use of economic classroom experiments with students (Fels, 1993; Gremmen & Potters, 1997). However, as the objectives of an experimenter and a teacher in economics are fundamentally different, economic experiments aiming at reaching educational goals instead of scientific goals are modified for their application in classroom settings specifically (DeYoung, 1993; McKinnon, 1996). The next paragraphs discuss the main design features of economic classroom experiments with regard to their goals, participants, instructions, use of contexts, analysis of data, and debriefing.
As pointed out in section 1.2, a main goal of a teacher in economics is increasing student comprehension of economic concepts. Hence, economic classroom experiments are designed in a way that allows students to grasp understanding of existing economic theory. This is often done in one experimental condition only, hence, no random assignment of students to conditions is necessary (DeYoung, 1993). The participants in an economic classroom experiment are regular students, who might already know each other and are used to interacting with each other in the social context of their own class (DeYoung, 1993).

Before an economic classroom experiment starts, all students receive instructions from their teacher. Carefully premeditated instructions set the stage for the experiment and strive to avoid inessential side comments from the students (Holt, 1999). As students are made aware that the experiment aims at helping them to acquire important knowledge of economic concepts, monetary rewards are considered unnecessary to guide student performance during the experiment (Cheung, 2003; Dickie, 2006; Stodder, 1998). The addition of a context in the experiment can enhance student understanding of the economic concepts at hand, for this may relate the experiment more directly to real world phenomena (Bernard & Bernard, 2005). The use of contexts does not disturb the research findings. Instead, contexts may increase the authenticity of the teaching/learning experiences of the students, which is considered favorable for the understanding of economic concepts in an array of contexts (cf. Brown, Collins, & Duguid, 1989; Herrington & Oliver, 2000).

When the experiment is over, the students are often asked to analyze the data they generated and recorded during the experiment. These analyses will help the students to develop an understanding of the economic concepts at hand. Usually, a debriefing of the experiment takes place as well. The phase of debriefing is considered important, as it allows teachers and students to relate student observations, experiences, and analyses to specific economic concepts (Cartwright & Stepanova, 2012; Holt, 2003).
Collections of economic classroom experiments can, amongst others, be found in the publications by Bergstrom and Miller (1997; 1999; 2000), and via the archives edited by Delemeester and Neral (2008). Box 1.2 provides an example of such an economic classroom experiment to illustrate how it may work out in a classroom situation.

<table>
<thead>
<tr>
<th>Box 1.2</th>
<th>Illustration of an Economic Classroom Experiment</th>
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</thead>
</table>
| Wednesday afternoon. Economics class. Imagine a classroom without chairs and tables, filled with twenty-four, on average 15-years old students. Half of them is assigned to be buyers, the other half is assigned to be sellers. The buyers possess private information about their available budget that might suffice to buy a product. The sellers hold their private information with respect to the marginal costs of the product that they intend to sell. Beforehand, the teacher has read out the instructions that should be followed by the students. All students are allowed to walk through the classroom during a certain period of time and to negotiate. By doing so, some buyers and sellers will be able to close a deal at a certain price level. For example, a buyer with a budget of €10.00 and a seller with marginal costs of €7.00 will be able to negotiate upon a price somewhere in between €7.00 and €10.00. But it is not guaranteed that all buyers and sellers will close a deal, hence, some of them will end up empty-handed. During the experiment, the teacher might publicly announce all prices at which deals have been closed. Afterwards, students analyze the price levels at which agreements were reached, and try to formulate conclusions. During the debriefing with the students, the teacher will pay attention to the student findings and relate the results and observations to economic concepts and economic theory. And then the lesson ends. Following the example in Box 1.2, the main goal for students is to gain insight in how supply and demand result in a market equilibrium, and how this equilibrium evolves over time. The participants are regular students. The experimental instructions guide the expected trading behavior of the students. The context of this experiment is a simulated market environment in which suppliers and demanders meet each other and perform negotiations. When the experiment is over, students are asked to analyze their data. Finally, the teacher and the students relate the outcomes of the experiments to the concept of market equilibrium during the debriefing. From the perspective of constructive learning theory, the example in Box 1.2 illustrates the active and bottom-up nature of an economic classroom experiment. Students are straightforwardly induced into an economic situation, instead of being explained a theory in a
teacher-led and top-down fashion (Emerson & Taylor, 2004; Ortmann, 2003). Opportunities for gaining understanding of economic concepts occur both during and after the economic classroom experiment (DeYoung, 1993; Hawtrey, 2007). During the market experiment described in Box 1.2, students interact with each other in a simulated market environment. They experience how both their available budget (respectively production costs) and their negotiations with other students can affect the profitability of a deal: Sometimes you win, sometimes you lose. Meanwhile, the students produce the data that they can analyze at a later stage (Holt & McDaniel, 1996). When the experiment is over, students can be asked to analyze the experimental data, to discuss their findings, and to formulate conclusions with each other and their teacher (Fryer Jr., Goeree, & Holt, 2005; Holt, 1999).

As the inductive nature of economic classroom experiments allows students to experience and to investigate what is going on in economics, economic classroom experiments can be related to both experiential learning and inquiry learning (cf. Haus, 2009). Students involved in economic classroom experiments gain personal experiences by being experiment participants. At the same time, economic classroom experiments can be used to help students discover economic regularities and to assist them in generating hypotheses (Haus, 2009). Hence, next to gaining experiences by participating in the experiments, the students also become researchers who analyze the data (Bergstrom & Miller, 2000). This is why economic classroom experiments can be placed at the interplay of experiential learning and inquiry learning. Based on previous empirical research, the next section elaborates how economic classroom experiments may contribute to the economic literacy of students.

1.4 ECONOMIC CLASSROOM EXPERIMENTS AND ECONOMIC LITERACY

Two decades ago, evidence on the educational value of economic classroom experiments was largely non-empirical (Holt & McDaniel, 1996; Laury, 1999). This has been stated clearly by,
for example, DeYoung (1993, p. 348): “I am convinced of the efficacy of classroom market experiments. However, this conclusion is drawn from anecdotal evidence […] and subjective analysis”. Since then, thirteen empirical studies have emerged. Researchers studied the effects of a single experiment, a single simulation game, or a sequence of several experiments. Most of these studies followed a pretest-posttest-control-group-design, in which students in the experimental group participated in economic classroom experiments, and students in the control group were educated in a non-experimental way.

An overview of the main findings of each of these thirteen empirical studies from the viewpoint of economic literacy is presented in Table 1.1. Although it has been described in section 1.1 that economic literacy comprises of three components (knowledge, reasoning, and transfer), it was not possible to split up “economic knowledge” and “economic reasoning” in this table, as only three studies (Cardell et al., 1996; Ebbers, Macha, Schlösser, & Schuhen, 2012; Emerson & Taylor, 2004) distinguished between declarative knowledge (e.g., recognition of economic concepts) and procedural knowledge (e.g., economic reasoning). Consequently, outcomes are presented as effects of economic classroom experiments on economic knowledge and reasoning on the one hand, and transfer on the other. The last column of the table provides a short description of the main findings of each study.
<table>
<thead>
<tr>
<th>Source</th>
<th>Context and Number of Participants</th>
<th>Intervention</th>
<th>Economic Knowledge, Reasoning</th>
<th>Transfer</th>
<th>Short Description of the Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardell et al. (1996)</td>
<td>HE-US (n = 1,800)</td>
<td>A sequence of four experiments</td>
<td>+</td>
<td>N/A</td>
<td>Recognition and explicit reasoning scores improved significantly for the experimental cohort over the control cohort at one university, but at another university there is no net positive effect of participating in economic experiments in comparison to the control condition.</td>
</tr>
<tr>
<td>Frank (1997) ^</td>
<td>HE-GE (n = 830)</td>
<td>A single classroom experiment</td>
<td>+</td>
<td>N/A</td>
<td>The average share of correct answers is significantly higher in the experimental groups than in the control groups. Students who watched the experiment seem to score lower than those who participated in the experiment, but there might be a selection bias here, as participating was a voluntary activity.</td>
</tr>
<tr>
<td>Gremmen and Potters (1997)</td>
<td>HE-NL (n = 38)</td>
<td>A single simulation game</td>
<td>+</td>
<td>N/A</td>
<td>The students who participated in the simulation game significantly outperformed the students in the control condition on a multiple choice test. This effect remained present over time. There was no significant correlation between what students reported having learned and what they actually learned.</td>
</tr>
<tr>
<td>Yandell (1999)</td>
<td>HE-US (n = 66)</td>
<td>A sequence of six experiments</td>
<td>-</td>
<td>N/A</td>
<td>Participating in microeconomic experiments does not significantly improve microeconomic test results. The main factor explaining student performance at the final test seems high school grade point average. Student evaluations show a positive result of the experiments on a student’s attitude towards economics.</td>
</tr>
<tr>
<td>Source</td>
<td>Context and Number of Participants</td>
<td>Intervention</td>
<td>Economic Knowledge, Reasoning</td>
<td>Transfer</td>
<td>Short Description of the Main Findings</td>
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<tr>
<td>Cebula and Toma (2002)</td>
<td>HE-US ((n = 246))</td>
<td>A single simulation game</td>
<td>+</td>
<td>N/A</td>
<td>Participation in the simulation game significantly enhances the average student’s final examination score in comparison to the non-experimental condition. Instructor evaluation scores were better in the experimental group than in the control condition.</td>
</tr>
<tr>
<td>Emerson and Taylor (2004)</td>
<td>HE-US ((n = 300))</td>
<td>A sequence of eleven experiments</td>
<td>+</td>
<td>N/A</td>
<td>Students who were enrolled in an experimental setting significantly improved their test scores over students in the control group. This regards both basic knowledge and higher-level thinking. Student characteristics (such as being female and having a higher grade point average) can be considered predictors for a successful performance in experimental settings.</td>
</tr>
<tr>
<td>Dickie (2006)</td>
<td>HE-US ((n = 108))</td>
<td>A sequence of seven experiments</td>
<td>+</td>
<td>N/A</td>
<td>Students enrolled in the experimental setting significantly improved their microeconomics test scores over their counterparts in the control condition. Within the experimental groups, using a grade incentive neutralizes this positive impact.</td>
</tr>
<tr>
<td>Source</td>
<td>Context and Number of Participants</td>
<td>Intervention</td>
<td>Economic Knowledge, Reasoning</td>
<td>Transfer</td>
<td>Short Description of the Main Findings</td>
</tr>
<tr>
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<tr>
<td>Durham, McKinnon, and Schulman (2007)</td>
<td>HE-US ($n = 1,585$)</td>
<td>A sequence of thirteen experiments</td>
<td>+</td>
<td>N/A</td>
<td>Some economic experiments have a positive influence and some have no or even a negative influence on student performance. For example, a demand and supply experiment in microeconomics has the largest positive impact. Overall, exposure to experiments significantly improves retention test scores in comparison to the control group. Mainly multimodal and kinesthetic learners are positively affected by participating in experiments, whereas visual, aural, and read/write learners perform similar as in the control condition. Participation in microeconomic experiments does not significantly improve overall interest in economics compared to control group.</td>
</tr>
<tr>
<td>Mitchell (2008)</td>
<td>HE-US ($n = 223$)</td>
<td>A sequence of eighteen experiments</td>
<td>-</td>
<td>N/A</td>
<td>No statistical significant link between participating in experiments and test or final exam scores is established. Using experiments might lower student-instructor evaluations. Using microeconomic experiments increases the likelihood that students choose an economics major.</td>
</tr>
<tr>
<td>Dufwenberg and Swarthout (2009)</td>
<td>HE-US ($n = 75$)</td>
<td>A single classroom experiment</td>
<td>-</td>
<td>N/A</td>
<td>Student enrollment in a specific experiment has no significant impact on student performance on a related test question. No indications were found that participating in an experiment significantly influences the perception of the student on his/her ability to answer a related question right. No support was found for the influence of general student aptitude on knowledge test scores.</td>
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</tbody>
</table>
Table 1.1 (Continued)  
Empirical Studies on the Effects of Economic Classroom Experiments

<table>
<thead>
<tr>
<th>Source</th>
<th>Context and Number of Participants</th>
<th>Intervention</th>
<th>Economic Knowledge, Reasoning</th>
<th>Transfer</th>
<th>Short Description of the Main Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Haus (2009)</td>
<td>SE-GE ($n = 266$)</td>
<td>A sequence of two experiments</td>
<td>+/−</td>
<td>N/A</td>
<td>Student enrollment in economic classroom experiments seems beneficial for performance on a test in one out of five school settings only. Student self-reports, however, show that participating in experiments is more favorable for the perceived knowledge gains, motivation, and interest in microeconomics of students, than was attending regular lessons.</td>
</tr>
<tr>
<td>Cartwright and Stepanova (2012)$^b$</td>
<td>HE-UK ($n = 109$)</td>
<td>A sequence of ten experiments</td>
<td>+</td>
<td>N/A</td>
<td>Students performed significantly better at answering test questions that were based on an experiment if they had also written a report on that experiment.</td>
</tr>
<tr>
<td>Ebbers, Macha, Schlosser, and Schuhen (2012)</td>
<td>HE-GE ($n = 161$)</td>
<td>A sequence of eight experiments</td>
<td>−</td>
<td>N/A</td>
<td>No over-all positive effect of experimentation over lecturing was established, although, for procedural knowledge only, there was a tendency towards significance in favor of experimentation. There are indications that the use of experiments seems particularly favorable early in the curriculum. Students in the experimental group self-reported having learned little, even if they had answered all questions in the exams correctly, whereas students in the control group self-reported having learned much, even if they had answered most questions incorrectly.</td>
</tr>
</tbody>
</table>

Notes. $^a$: only 5 students per experimental group participated, the other students watched these players; $^b$: this study did not use an explicit control condition, but compared the effects of different experimental conditions; HE = higher education / SE = secondary education, in: -US = United States of America, -GE = Germany, -NL = the Netherlands, -UK = United Kingdom; $n$ = number of participants; $+/+/−$ = positive significant effect / mixed effect / no significant positive effect; N/A = no data available.
Four observations will be drawn based on the studies described in Table 1.1. The implications of each of these for upcoming empirical research with regard to economic literacy will be described subsequently. The first observation is that findings regarding the effect of economic experiments on the economic literacy of students are mixed. Seven studies report students in experimental groups to outperform students in control groups on knowledge tests (Cartwright & Stepanova, 2012; Cebula & Toma, 2002; Dickie, 2006; Durham et al., 2007; Emerson & Taylor, 2004; Frank, 1997; Gremmen & Potters, 1997). The active nature of economic classroom experiments as a teaching/learning activity is described as a general explanation for this finding. However, four other studies find no significant positive effect in favor of the experimental group over the control group (Dufwenberg & Swarthout, 2009; Ebbers et al., 2012; Mitchell, 2008; Yandell, 1999). In these studies, students actively participated in economic classroom experiments as well, hence, active participation in itself may not solely account for the positive student outcomes found by the seven studies mentioned before. This argument is further strengthened by taking a closer look at the studies by Cardell et al. (1996) and Haus (2009). These two studies compare the use of economic classroom experiments in several universities and schools and find, amongst others, positive effects of these experiments in one place but not in another. The inability to replicate findings found in one university or school to another suggests that supplementary factors besides of active participation in the experiment may contribute to the learning outcomes of the students. On the other hand, as the other eleven empirical studies made use of different (sets of) economic classroom experiments and testing materials, outcomes with regard to the economic literacy of students are difficult to compare between each separate study. Therefore, it may be sensible to use a standard set of experiments over and over again during a sequence of empirical studies. This may provide additional evidence to the limited findings emerging from the previous studies with regard to using economic classroom experiments to increase the economic literacy of students.
Second, although economic literacy comprises of three components (knowledge, reasoning, and transfer) as described in section 1.1, only three studies distinguished between declarative knowledge (such as recognition of economic concepts) and procedural knowledge (such as economic reasoning). Cardell et al. (1996) find that both knowledge of economic concepts and reasoning scores improve significantly for students who participated in a sequence of four economic classroom experiments at one university. However, as mentioned before, a second study at another university did not replicate these findings. Emerson and Taylor (2004) reveal that enrollment in economic classroom experiments improves both knowledge of basic economic concepts and higher-level economic thinking. Finally, Ebbers et al. (2012) report no positive effect on the over-all economic literacy of students who participate in economic classroom experiments over students attending regular lessons. However, they identify a tendency towards significance in favor of the experimental group with regard to their acquisition of procedural knowledge, such as the ability of students to set up economic reasoning properly. Another finding, based on Table 1.1 and with regard to the concept of economic literacy as described in section 1.1, is that none of the thirteen previous studies seems to have addressed how economic classroom experiments may support the transfer of an economic concept across contexts. Upcoming empirical research studying the impact of economic classroom experiments on each of the three individual aspects of economic literacy may contribute to these blank spots in the literature.

A third observation is that documentation and analysis of the teaching/learning processes that took place in the classroom during the performance of economic classroom experiments seems missing in any of the thirteen previous studies. Perhaps, treating learning as a “black box” has even affected the (in)ability of previous studies to identify which elements of economic classroom experiments may have contributed to the learning outcomes of the students. To shed light on the processes that take place during economic classroom experiments, future empirical research may include basic qualitative measures to capture at least some the
teaching/learning processes involved in a more explicit way. When aiming at uncovering some of these teaching/learning processes, it may be useful to take a closer look also at the two studies that deviated from the dominant pretest-posttest-control-group-design. Frank (1997) used a design in which only five of his students actually participated in an economic classroom experiment, while the majority of his students monitored what happened. Cartwright and Stepanova (2012) did not compare experimental lessons to regular lessons, but contrasted different experimental settings. Upcoming research that explicitly compares variants of economic classroom experiments may advance the understanding of which elements of these experiments may foster or impair the economic literacy of students.

The fourth and final observation is that twelve out of these thirteen empirical studies regarded the level of undergraduate education. Only the study by Haus (2009) was performed with secondary school students. Although this particular study indicates that experiment participation seems beneficial for student motivation, interest in economics, and self-perceived knowledge gains, performance data resulting from knowledge tests do not back up these findings. More research is needed in the context of secondary education to increase understanding of the educational value of economic classroom experiments in a non-university context.

In sum, the empirical literature seems focused on measuring economic literacy of mainly university students in an output-based way in which hardly any distinctions are made between knowledge of economic concepts, the ability to set up economic reasoning, and the transfer of economic concepts across contexts. The studies presented in the present thesis intend to expand these scopes and approaches by studying the use of an array of economic classroom experiments in the context of secondary education and by illuminating some of the basic teaching/learning processes next to measuring the student output on all three components of economic literacy.
1.5 RESEARCH QUESTION AND SET-UP OF THIS THESIS

The general aim of this thesis is to explore if and how economic classroom experiments can be used to support the economic literacy of students in secondary education. The main research question in this thesis is: *How can economic classroom experiments support secondary school students in gaining knowledge of economic concepts, setting up economic reasoning, and transferring economic concepts across contexts?*

The remainder of this thesis is organized as follows (see Table 1.2 for an overview). Chapter 2 investigates the effects of economic classroom experiments on gaining knowledge of economic concepts. Chapter 3 examines how economic classroom experiments can contribute to economic reasoning skills. Chapter 4 explores whether and how economic classroom experiments can be used for identifying, formulating, and illustrating an economic concept. At the core of this chapter is the process of analogical reasoning, which is considered fundamental for the ability of students to transfer economic concepts across contexts. The studies described in chapters 2-4 are designed around the neoclassical concepts of supply, demand, and market equilibrium. Chapter 5 summarizes the findings from these empirical studies and elaborates how a less neoclassical and more behavioral economic perspective on secondary school economics may contribute to the economic literacy of students as well. Following this behavioral economic perspective, the research in Chapter 6 focuses on identifying the merits and drawbacks of using economic classroom experiments when aiming at the far transfer of a behavioral economic concept across contexts. Finally, Chapter 7 formulates general conclusions, addresses limitations of the studies, suggests directions for further research, and discusses recommendations for both classroom practice and curriculum development. As each of these chapters has been conceived as an independent piece of writing and despite all efforts to reduce commonalities, readers may encounter some overlap between the chapters. Please note that all data gathered in the four empirical studies as presented in this thesis were stored in
secured SPSS-database files at HAN University network drives. These data are available upon request by contacting the principal investigator.

Table 1.2  Overview of the Thesis

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Title</th>
<th>Short Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>General Introduction</td>
<td>Introduces the theoretical framework of economic classroom experiments.</td>
</tr>
<tr>
<td>2</td>
<td>Participate or Observe? Effects of Economic Classroom Experiments on Students’ Knowledge of Economic Concepts</td>
<td>Investigates how economic classroom experiments may support students to acquire knowledge of economic concepts.</td>
</tr>
<tr>
<td>3</td>
<td>Effects of Economic Classroom Experiments on Economic Knowledge and Reasoning in Secondary Education</td>
<td>Investigates how economic classroom experiments may support students to set up economic reasoning.</td>
</tr>
<tr>
<td>3½</td>
<td>You Won’t See It Till You Get It</td>
<td>Prepares for the upcoming topics of knowledge transfer and analogical reasoning.</td>
</tr>
<tr>
<td>4</td>
<td>Supporting Transfer of Economic Concepts Through Analogical Reasoning in Secondary Education</td>
<td>Investigates the extent to which economic classroom economic experiments and written stories may support students in identifying, formulating, and illustrating an overarching neoclassical economic concept.</td>
</tr>
<tr>
<td>5</td>
<td>Fully Rational or Rational Fools?</td>
<td>Elaborates the necessity of including a behavioral economic perspective in secondary education when aiming at increasing the economic literacy of the students.</td>
</tr>
<tr>
<td>6</td>
<td>Participation in a Behavioral Economic Experiment Advances Far Transfer</td>
<td>Investigates how a behavioral economic experiment supports students in transferring an economic concept across contexts.</td>
</tr>
<tr>
<td>7</td>
<td>Discussion and Conclusion</td>
<td>Formulates general conclusions, discusses recommendations, addresses limitations of the studies, and provides suggestions for further research.</td>
</tr>
</tbody>
</table>

Note(s). -
REFERENCES


Centrale Examencommissie Vaststelling Toetsopgaven (CEVO, 2007). *Syllabus Economie voor havo en VWO* [Syllabus for Economics in General Secondary and Pre-University Education]. Utrecht: CEVO.


CHAPTER 2
CHAPTER 2

PARTICIPATE OR OBSERVE? EFFECTS OF ECONOMIC CLASSROOM EXPERIMENTS ON STUDENTS’ KNOWLEDGE OF ECONOMIC CONCEPTS

ABSTRACT
Economic classroom experiments are controlled interactive teaching/learning exercises targeting the comprehension of economic concepts in an inductive way. Aiming at increasing students’ knowledge of economic concepts, two experimental conditions, in which students either participated in \( n = 44 \) or observed \( n = 49 \) economic classroom experiments, and one control condition, in which students attended non-experimental lessons \( n = 41 \), were compared. ANCOVAs and contrast analyses indicate that interactive learning from experiences in economic classroom experiments is beneficial for learning economic concepts. Reasons for this are elaborated.

KEY WORDS
Economic classroom experiments; economic literacy; secondary education; interactive, constructive, active, passive.

JEL-CLASSIFICATION
A21, D00.

A VERSION OF THIS CHAPTER HAS BEEN ACCEPTED FOR PUBLICATION IN THE EUROPEAN JOURNAL OF PSYCHOLOGY OF EDUCATION
2.1 INTRODUCTION

Although most people once participated in economics courses, many seem to know little about economic matters (e.g., Hansen, Salemi, & Siegfried, 2002; Walstad & Rebeck, 2002). The extent to which one is able to recall and apply economic concepts and insights in everyday live situations is often referred to as economic literacy (Salemi, 2005). As brought forward in Chapter 1, it embodies the understanding of economic concepts, the skill to set up economic reasoning, and the ability to transfer economic concepts across contexts. Economic literacy has a broad scope, ranging from gaining understanding under which conditions and how markets work on the one hand, to household affairs, such as personal interest calculations, on the other.

The current study focuses on the understanding of economic concepts in the context of microeconomics, which studies the behavior of individuals making economic decisions in market environments (e.g., Schotter, 2003). However, as has been pointed out in Chapter 1, the dominant teaching methodology in economics might be unbenefficial for achieving a thorough understanding of economic concepts. It has been witnessed in both the United States (e.g., Becker & Watts, 2001; Wentworth, 1987), and the Netherlands (e.g., Meijerink, 1999; Kneppers, 2007; Kneppers, Elshout-Mohr, & Van Boxtel, 2007) that teachers in economics tend to focus on facts and concepts and appear to favor deductive “chalk-and-talk” teaching methods. The cognitive processes underlying such lessons often include a teacher-led activation of the pre-knowledge of the students and the subsequent assimilation of new information by the students through reacting to external sources of information as presented by their teacher (cf. Chi, 2009).

Typical communication in classes such as these follows the structure of initiation, response, and evaluation (IRE): The teacher asks a question, a student responds, and the teacher judges the quality of the student answer (e.g., Mason, 2001; Mehan, 1979; Mercer, 1995). Researchers in the cognitive sciences, however, seem to agree that a learning environment should support autonomy and active learning. It should guide students in solving problems and
incorporate relevant and meaningful learning tasks that are situated in realistic contexts, and promote students to think and work together (e.g., Vosniadou, Ioannides, Dimitrakopoulou, & Papademetriou, 2001). The latter could be supported by encouraging dialogues amongst students and their teachers (e.g., Alexander, 2004; Mercer, 1995). At the same time, students should be provided with enough guidance to prevent a cognitive overload of their short term memory capacity when performing learning activities (Kirschner, Sweller, & Clark, 2006).

To offer students a learning environment that includes an opportunity to experience and observe microeconomic concepts that are normally only described in texts, tables, and graphs in textbooks (e.g., Emerson & Taylor, 2004), this study makes use of economic classroom experiments. Economic classroom experiments can be described as controlled interactive teaching/learning activities that target the comprehension of a specific economic concept in a “bottom-up” way (e.g., Holt & McDaniel, 1996; Holt, 2003; Laury, 1999). In section 2.2, the learning processes in economic classroom experiments are described. The research question and hypotheses are stated in section 2.3. Section 2.4 describes the research method. The results are presented in section 2.5., and the findings are discussed and elaborated on in section 2.6.

2.2 ECONOMIC CLASSROOM EXPERIMENTS

Before elaborating on the learning processes in economic classroom experiments, an illustration of such an experiment will be portrayed first. A microeconomic classroom experiment might, for example, engage students in a simulated market (e.g., Bergstrom & Miller, 1997; Chamberlin, 1948). Half of the students are assigned the role of buyers, who possess private information about their available budget for acquiring a product. The other students are sellers of the same product, each holding their own private information about their production costs. Hence, different levels of budgets and costs are present in the market. Students are instructed to move around the classroom and to negotiate prices during a fixed period of time. Buyers and sellers will close deals at certain price levels, which will be publicly noted on the whiteboard.
Several rounds are played, during which the same budgets and marginal costs will be present in the market. Students try to maximize their own profits, amongst others by noticing previous successful deals. Students observe that prices will converge towards the theoretical equilibrium level in several rounds.

Economic classroom experiments such as these can give students “‘real-world’ experiences but protect them from harmful or irrelevant elements that could impede, rather than support, their learning” (Stein, Isaacs, & Andrews, 2004, p. 240). Students are also actively engaged in what can be labeled a scientific discovery process (Lazonder, Hagemans, & De Jong, 2010; Löhner, Van Joolingen, Savelsbergh, & Van Hout-Wolters, 2005; Zion, Michalsky, & Mevarech, 2005). They develop elementary scientific skills such as generating data, monitoring, and analyzing information (e.g., Van Joolingen, 1999; Van Joolingen & De Jong, 1997). While taking part in an economic classroom experiment, students learn by doing and through their own experiences and those shared by others (cf. Dewey, 1938/1997).

Only a limited number of thirteen previous studies investigated the educational value of economic classroom experiments empirically (for an overview see Chapter 1). As all but one of these studies have been employed at the undergraduate level, little is known of the effects of economic classroom experiments on the economic literacy of students in secondary education (cf. Haus, 2009). Most of these studies follow a pretest-posttest-control-group-design. Students in the experimental group participate in economic classroom experiments and students in the control group are educated in a non-experimental way. However, Frank (1997) takes a different approach. He uses a design in which only some of his students actually participated in an economic classroom experiment, while all other students monitored what happened. This learning by means of observing others can be called observational learning (e.g., Schunk, 1987). Although some might expect participating students to learn more from economic classroom experiments than students in their roles as observers (e.g., Bergstrom & Miller, 2000), from an empirical perspective “it is not clear that actually taking part in the experiment increases the
proportion of right answers more than merely watching it being performed” (Frank, 1997, p. 766).

By participating in or observing an economic classroom experiment, students construct knowledge together through dialogue with both fellow students and their teacher (cf. Edwards & Mercer, 1989). Hence, the use of economic classroom experiments during economics education is expected to push students towards interaction. This is in line with a more sociocultural view on education, in which learning is considered a process in which a student becomes an active member of a community and discovers the rules of the discipline together with others (Kaartinen & Kumpulainen, 2002). From this angle, cognitive development is a social and communicative process in which learning is influenced by the surrounding circumstances and the contributions of other people involved (e.g., Mercer, 1995; Vygotsky, 1978). The latter stresses the importance of participation and communication once more (Wenger, 1998).

The actual place and amount of dialogue in learning conditions may differ. It might therefore be useful to take closer inspection to a taxonomy that distinguishes among interactive, constructive, active, and passive learning activities (Chi, 2009). The cognitive processes underlying this taxonomy shift from students creating knowledge together to students being mainly attentive. Chi (2009) hypothesizes and illustrates that students engaged in interactive learning may outperform students engaged in constructive learning, who in turn may surpass active learners. The present study tests this hypothesis by introducing three research conditions: An interactive condition in which all students participate in economic classroom experiments, a constructive condition in which students observe video recorded economic classroom experiments, and an active direct instruction control condition in which students attend lectures. An overview is presented in Table 2.1. Please note that the taxonomy is primarily used to identify the focal point of the main teaching/learning activities within each condition and does not impose these conditions to be exclusively interactive, constructive, or active.
Following Table 2.1, the interactive activities in the current research focus on students learning together about their own experiences in a dialogue. When participating in economic classroom experiments, students are encouraged to think and work together and learn in a social, communicative environment, where their thinking is influenced by their own experiences and by contributions of fellow students and the teacher. When shifting to the constructive and the active research conditions, both of these aspects are reduced gradually. For example, observing videos individually trims down both student interactions and first-hand experiences. Students in the video condition construct concepts based on their observations and are thus merely integrating the information with which they were provided with their own pre-knowledge.

To be able to identify the nature of the interactions and communication in classroom settings such as these, an additional framework might be helpful. Alexander (2004) distinguishes between five kinds of talk: Rote (fact drilling through repetition), recitation (questions that stimulate recall of what has been learned), instruction (explain what students should do and how they should do it), discussion (exchanging ideas, sharing information), and dialogue (teacher and students build on their own and other’s ideas to achieve common understanding). Furthermore, to take closer inspection to the types of dialogue that appear during class, Mercer (1995) and Wegerif (2001) suggest to distinguish between disputational talk (i.e. short exchanges, competitive in nature), cumulative talk (i.e. accumulating knowledge, but being uncritical), and exploratory talk (i.e. sharing knowledge including the critical challenge each other’s ideas via explicit reasoning).
Table 2.1 Application of the ICAP-Framework

<table>
<thead>
<tr>
<th>Cognitive Processes (Chi, 2009)</th>
<th>Interactive</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jointly creating, e.g., incorporating the contributions of fellow students.</td>
<td>Creating, e.g., integrating new information with existing knowledge.</td>
<td>Attending, e.g., activating present knowledge and accumulating new information.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Overt Activities (Chi, 2009)</th>
<th>Constructive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activities that engage learners to construct knowledge together in dialogue.</td>
<td>Activities that help learners to self-construct knowledge.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description of Teaching/Learning Activities (current research)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Students are introduced on the topic by their teacher and thereafter participate together in a sequence of four economic classroom experiments. While interacting, the students themselves generate data. Students have to analyze these data afterwards together and formulate conclusions related to the economic concepts at hand.</td>
</tr>
<tr>
<td>Students are introduced on the topic by their teacher and thereafter watch a video recorded sequence in which peers perform four experiments. The observing students take notes. They analyze these data afterwards and formulate conclusions related to the economic concepts at hand.</td>
</tr>
<tr>
<td>The topic is explained by the teacher. Students take notes. Hereafter, the students are provided with exercises to apply these economic concepts, in order to formulate conclusions related to the economic concepts at hand.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching/Learning Activities in Key-Words (current research)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participation</td>
</tr>
<tr>
<td>Own experiences</td>
</tr>
<tr>
<td>Interacting / communicating</td>
</tr>
<tr>
<td>Knowledge construction</td>
</tr>
<tr>
<td>Formulating conclusions</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Description of the Condition (current research)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiment participation condition</td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Notes: A: ICAP = Interactive, Constructive, Active, and Passive, source: Chi (2009); B: The category “Passive” has been omitted, as passive teaching/learning activities were not part of the research conditions.

2.3 RESEARCH QUESTIONS AND HYPOTHESES

The aim of the present study is to explore the benefits of participation in economic classroom experiments on secondary school students’ knowledge gains of economic concepts. In line with Chi (2009) it is predicted that students will gain more knowledge from being enrolled in the interactive and constructive experimental conditions, than from their attention of regular
lessons in the control condition (Hypothesis 1). It is also predicted that students will gain more knowledge from their participation in economic classroom experiments than from their observations of video recorded experiments (Hypothesis 2). Furthermore, as previous empirical studies do not explicitly report on the actual student experiences and classroom interactions, the current study aims at identifying the kind of classroom interactions and experiences that take place during the participation in and observation of economic classroom experiments.

2.4 METHOD
2.4.1 PARTICIPANTS
Teachers in lower general and pre-university secondary education and their students were recruited via the professional network of the investigators. They were randomly assigned to the experiment participation condition (2 classes), the video observation condition (2 classes), and the control condition (3 classes). Before the research started, the students had acquired quite similar knowledge of basic economic principles as they were enrolled in their first year of formal economics education. The research took place in June 2012 and only one condition per school was applied. In total 134 students participated, on average aged 14.7 years (SD=0.53), and 64 of them (47.8%) were female. Student data, such as sex, age, and grade point averages (GPAs), were collected from official school records (cf. Maxwell & Lopus, 1994). To measure student motivation for the school subject of economics at baseline, a slightly adapted version of the validated Attitude Scale towards Mathematics (ASM) by Martinot, Kuhlemeier, and Feenstra (1988) is included. In the version used, the term “mathematics” is replaced with “economics”. Students scored the extent to which they agreed with statements such as: “What I learn during economics classes is of little use outside school” on a 4-point Likert scale, ranging from “totally disagree” to “totally agree”. Exploratory factor analysis indicated that this version of the questionnaire measures the four underlying constructs of pleasure, no fear/difficulty, interest/devotion, and profit/relevance. In line with previous findings (Welp, Dieteren, &
Kneppers, 2009), each of these factors shows a good internal consistency ($\alpha > .750$). Table 2.2 shows summary statistics concerning participant data and learning preconditions.

ANOVA\text{s showed significant mean differences between the three conditions with respect to the grade point averages of economics: }F(2, 130)=31.97, p<.001, \eta^2=.33, \text{ mathematics: }F(2, 130)=14, p<.001, \eta^2=.18, \text{ Dutch language: }F(2, 130)=11.06, p<.001, \eta^2=.15, \text{ and the profit/relevance ASM-scores: }F(2, 116)=10.24, p<.001, \eta^2=.15.

Table 2.2: Demographic Data and Learning Preconditions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total All Conditions $N=134$</th>
<th>Experiment Participation Condition $N=44$</th>
<th>Video Observation Condition $N=49$</th>
<th>Control Condition $N=41$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>14.7 (0.53)</td>
<td>14.7 (0.54)</td>
<td>14.7 (0.56)</td>
<td>14.6 (0.49)</td>
</tr>
<tr>
<td>Female</td>
<td>64 (47.8%)</td>
<td>21 (47.7%)</td>
<td>23 (46.9%)</td>
<td>20 (48.8%)</td>
</tr>
<tr>
<td>GPA Economics</td>
<td>6.7 (0.97)</td>
<td>7.3 (0.90)</td>
<td>6.9 (0.88)</td>
<td>5.9 (0.56)</td>
</tr>
<tr>
<td>GPA Mathematics</td>
<td>6.7 (1.17)</td>
<td>6.9 (1.18)</td>
<td>7.1 (1.11)</td>
<td>6.0 (0.88)</td>
</tr>
<tr>
<td>GPA Dutch</td>
<td>6.4 (0.69)</td>
<td>6.6 (0.63)</td>
<td>6.5 (0.65)</td>
<td>6.0 (0.65)</td>
</tr>
</tbody>
</table>

(Continued)
Table 2.2
(Continued)

Demographic Data and Learning Preconditions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total All Conditions N=134</th>
<th>Experiment Participation Condition N=44</th>
<th>Video Observation Condition N=49</th>
<th>Control Condition N=41</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASM Pleasure</td>
<td>23.5 (4.88)</td>
<td>24.2 (4.88)</td>
<td>22.7 (5.07)</td>
<td>23.7 (4.62)</td>
</tr>
<tr>
<td>ASM No fear / difficulty</td>
<td>26.6 (4.07)</td>
<td>27.8 (3.60)</td>
<td>26.4 (3.92)</td>
<td>25.7 (4.47)</td>
</tr>
<tr>
<td>ASM Interest / devotion</td>
<td>17.8 (4.28)</td>
<td>17.1 (4.02)</td>
<td>17.9 (4.34)</td>
<td>18.5 (4.44)</td>
</tr>
<tr>
<td>ASM Profit / relevance</td>
<td>25.3 (4.04)</td>
<td>23.7 (4.45)</td>
<td>24.7 (3.42)</td>
<td>27.5 (3.54)</td>
</tr>
</tbody>
</table>

Notes. All data are reported [mean (SD)], except for Female: [Number of female students (%)]; Age: The age of the respondent; Female: Number of female students; GPA: Grade point average on a scale ranging from 1 (lowest possible score) to 10 (highest possible score); ASM: The slightly adapted version of the Attitude Scale towards Mathematics (Martinot et al., 1988).

2.4.2 MEASURES AND COVARIATES

2.4.2.1 ECONOMIC LITERACY: CONCEPT KNOWLEDGE

To measure economic literacy, narrowed down to students’ understanding of the microeconomic concept market, a pretest and a posttest were constructed and administered. Each of these tests consisted of 35 multiple choice questions and 5 open questions. Each correct answer was scored one point, hence adding up to a maximum score of 40 points. The combined test items in the pretest addressed the same topics, knowledge dimensions, and cognitive process dimensions as the test items in the posttest (cf. Krathwohl, 2002). However, to eliminate the possibility that student scores might improve by remembering pretest items, posttest items were not literary identical to these.
The multiple choice questions included four possible answers, out of which only one was correct. Points to these questions were awarded by one rater and checked by a second rater. For rating the open questions, such as: “Given the following case, please describe and explain how the average productivity of Imperial Airways London developed between 1924 and 1939”, two raters independently checked the student answers. Reliability analysis showed a fair internal consistency of the multiple choice questions in the pretest ($\alpha=.70$) and a rather good consistency in the posttest ($\alpha=.83$). With respect to rating the open questions, an intra-class correlation coefficient (two way mixed model, absolute agreement, single measures) indicated substantial consistency amongst the two raters: ICC=.71 ($p < .001$), 95% CI (0.55, 0.82).

Finally, knowledge gains were calculated as standardized gain scores (cf. Siegfried & Fells, 1979): Posttest scores minus pretest scores were divided by the maximum possible improvement based on the pretest score of a student. The maximum standardized gain score is therefore 1, which would indicate a student who has gained 100% of the maximum possible improvement score.

### 2.4.2.2 INTERACTIONS, COMMUNICATION, AND EXPERIENCES

To capture the classroom interactions that took place during the participation in and observation of economic classroom experiments in the experiment participation condition and in the video observation condition respectively, a video camera was placed on a tripod in front of the students during class. A coding scheme based on the typology by Alexander (2004) was applied to classify these interactions. For analytic purposes, the category “dialogue” was divided into teacher-student dialogue (in which the teacher is talking with the students) and student-student dialogue (in which students build on their own ideas together). Two raters independently scored the occurrence of each of these interactions. The intra-class correlation coefficient (two way mixed, absolute agreement, single measures) showed a rather good consistency among the
raters: ICC=.88 (p=.004), 95% CI (0.46, 0.98). Hereafter, the over-all nature of the talk within each condition was characterized by using the distinction between disputational, cumulative, and exploratory talk (e.g., Wegerif & Mercer, 1997).

So-called learner reports (e.g., De Groot, 1974; Van Kesteren, 1993) were administered as a post-intervention measure of the subjective student experiences. De Groot (1974) considers the students themselves as experts of what they learned during class. He states that student self-reports can be regarded a powerful tool for “getting hold of not-easily-measurable objectives” (De Groot, 1974, p. 21). Students were asked to complete sentences such as: “The most important thing I learned with respect to economics is…”, and: “During these lessons, I learned that I am good at…”. For the purpose of analysis, per question all written student experiences were printed on cards, sorted in groups with similar responses, and labeled accordingly by two independent raters. The intra-class correlation (two way mixed model, absolute agreement, single measures) between the two raters was found to be substantial: ICC=.76 (p < .001), 95% CI (0.50, 0.89).

2.4.3 RESEARCH DESIGN

Three conditions were developed: An interactive experiment participation condition, a constructive video observation condition, and an active direct instruction control condition. The theoretical underpinnings of each condition are described in Table 2.1. As market experiments are prominent in the literature on economic classroom experiments (e.g., Bergstrom, 2003; Chamberlin, 1948; DeYoung, 1993; Menkhaus, Yakunina, Bastian, & Esipov, 1997), the microeconomic concept market was selected as subject matter for the interventions.

In the experiment participation condition, all students participated in a sequence of four economic classroom experiments. These are described in detail in Table 2.3. All students in the video observation condition watched a video recorded sequence in which peers participated in the same four experiments. These videos were recorded during an afternoon session using a real
teacher and her students. Peers were used in these videos, as students who are more or less equivalents to the observers are hypothesized to be the best role model (e.g., Schunk, 1987; Schunk & Hanson, 1989). In the editing process, time-consuming scenes regarding, amongst others, the teacher’s activities while rearranging chairs and tables in the classroom, were deleted. Each final video provided the observing students with a general overview of the interactions taking place during the experiment, meanwhile following a few players in more detail, as well as the outcomes of each experiment. Finally, DVDs were created that consisted of four videos each, lasting 10:15, 7:05, 5:14, and 5:04 minutes respectively. Students watched all videos once and were not able to control them in any way. The control condition included educational materials in the format of direct instruction, and accompanying exercises with regard to the subtopics of productivity, demand behavior, and supply and demand in a competitive market.

To ensure alignment (Anderson, 2002; Biggs, 1999), taxonomy tables based on the revised taxonomy of Bloom (Krathwohl, 2002) were filled out with learning goals, teaching/learning activities, and test items. Goals and test items were identical for all research conditions. Teaching/learning activities were aligned with goals and assessment items in each condition. Table 2.3 illustrates how teaching/learning activities differ across conditions.
Table 2.3  
Content of the Three Conditions

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Experiment Participation Condition</th>
<th>Video Observation Condition</th>
<th>Control Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Groups of students fold airplanes out of sheets of paper. They experience, discuss, calculate, and visualize that adding extra employees without adding extra trucks or tools will first increase, but finally decrease production per worker(^4).</td>
<td>Students observe a video in which groups of students are folding paper airplanes. They observe, discuss, calculate, and visualize that adding extra employees without adding extra trucks or tools will first increase, but finally decrease production per worker.</td>
<td>Students listen to their teacher who tells them about Adam Smith’s notion that specialization may increase productivity. Afterwards, students calculate, draw, and discuss graphs on increasing and decreasing productivity.</td>
</tr>
<tr>
<td>2</td>
<td>Individual students have to place bids in an English and in a Dutch auction, in both of which a can of Coca Cola can be bought. They collect data, and calculate and draw graphs of demand behavior(^3).</td>
<td>Students observe a video in which individual students place bids in an English and in a Dutch auction, in both of which a can of Coca Cola can be bought. The observing students collect data, and calculate and draw graphs of demand behavior.</td>
<td>Students listen to their teacher who tells them about the demand behavior of consumers in different circumstances. Students are provided with an exercise so they could calculate and draw graphs of demand behavior.</td>
</tr>
</tbody>
</table>

(Continued)
### Table 2.3 Content of the Three Conditions (Continued)

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Experiment participation condition</th>
<th>Video observation condition</th>
<th>Control condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Students buy and sell virtual apples in a market environment. They will negotiate and seek to reach agreement on prices. Students calculate individual earnings and notice prices to converge towards equilibrium over several rounds&lt;sup&gt;C&lt;/sup&gt;.</td>
<td>Students observe a video in which other students buy and sell virtual apples in a market environment, thereby negotiating and seeking to reach agreement on prices. Students observe and calculate price convergence towards equilibrium over several rounds.</td>
<td>Students listen to their teacher who tells them how supply and demand converge towards an equilibrium price in a competitive market. Students are provided with an exercise from which they could draw supply and demand curves, and compute market equilibrium.</td>
</tr>
<tr>
<td>4</td>
<td>Students are buyers and sellers in a market environment in which a price floor has been set. They will negotiate and seek to reach agreement on prices. Students calculate individual earnings, and notice what happens to the behavior of certain buyers and sellers and the price convergence towards equilibrium, due to the price floor, over several rounds&lt;sup&gt;D&lt;/sup&gt;.</td>
<td>Students observe a video in which other students are buyers and sellers in a market in which a price floor has been set. The videotaped students negotiate and seek to reach agreement on prices. Students observe and calculate individual earnings and notice what happens to the behavior of certain buyers and sellers and the price convergence towards equilibrium, due to the price floor, over several rounds.</td>
<td>Students listen to their teacher who tells them how and why governments can interfere in markets by means of a price floor. Students are provided with an exercise in which they draw supply and demand curves and notice what happens as a result of a price floor.</td>
</tr>
</tbody>
</table>

**Notes.** Sources: <sup>A</sup>: “Measuring productivity” (Bergstrom & Miller, 1997; 1999); <sup>B</sup>: “Demand for Coca Cola” (Grol, 2009); <sup>C</sup>: “The apple market” (Bergstrom & Miller, 1997; 1999); <sup>D</sup>: “Supply and demand: Government interference” (Grol, 2009).

In each condition, the teaching/learning materials consisted of protocols that should be followed by the teachers during four classes of about 50 minutes each. These protocols intended to
prevent a cognitive overload (cf. Kirschner et al., 2006) by providing detailed instructions and hand-ins to the students for the ease of recording their findings. Protocols started with learning goals and an introduction, followed by a content description and all teaching/learning activities. The protocols ended with guidelines and questions for debriefing, such as: “Please describe and illustrate the relationship between price and quantity demanded”, and: “How may non-monetary factors affect the quantity demanded in a specific situation?”. These questions were similar in all conditions except for the context and teaching/learning activities to which they referred.

2.4.4 PROCEDURE

All students were taught and tested by their own teacher, in order to reduce experimenter-demand-effects (e.g., Zizzo, 2008). Beforehand, all teachers received personal instructions from the principal investigator. These activities involved a training for every teachers. During this training, all teaching/learning materials and measurement instruments were handed out and discussed to familiarize all teachers with the upcoming teaching/learning activities. At the end of this meeting, teachers were well aware which documents they had to hand out to their students at which moment in time, as well as how they could collect and hand-in the data afterwards. In the first meeting of the study, students filled out the ASM-questionnaire and the knowledge pretest. In meetings 2-5, students attended their sequence of teaching/learning activities in one of the research conditions only. During the sixth meeting, students filled out the knowledge posttest and the learner reports.
2.5 RESULTS

2.5.1 ECONOMIC LITERACY: CONCEPT KNOWLEDGE

Positive mean effects on standardized knowledge gain scores were found in all conditions: Experiment participation: $M=0.29$ (SD=0.29), video-observation: $M=0.12$ (SD=0.25), and control condition: $M=0.01$ (SD=0.29). ANOVA showed a main effect of enrollment in a particular condition on standardized knowledge gain scores: $F(2, 124)=10.97, p<.001, \eta^2=.15$. As grade point averages for economics $r(124)=.32, p<.001$, mathematics $r(124)=.19, p=.033$, and Dutch language $r(124)=.38, p<.001$ were correlated with standardized knowledge gains, an ANCOVA was performed. ANCOVA [between-subjects factor: Treatment; covariates: Grade point averages for economics, mathematics, and Dutch language] revealed that the main effect of enrollment in a particular condition on standardized knowledge gain scores remained present after adjusting for these confounders: $F(2, 120)=4.23, p=.017, \eta^2=.07$. Results are presented in Table 2.4.

Helmert contrast analysis showed that being enrolled in the constructive or interactive learning condition increased standardized knowledge gains compared to being enrolled in regular lessons (Rest.vs.Control, contrast estimate =.13, SE =.06, $p = .042$). This finding confirms the first research hypothesis. Performing experiments further increased standardized knowledge gains compared to observing videos (Experiment.vs.Video, contrast estimate =.13, SE =.06, $p = .027$). This finding confirms the second research hypothesis.
Table 2.4  Effects for Predictors of Economic Literacy$^\text{A}$

<table>
<thead>
<tr>
<th>Variables</th>
<th>df</th>
<th>MS</th>
<th>F</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corrected model</td>
<td>5</td>
<td>.47</td>
<td>6.79</td>
<td>.001</td>
</tr>
<tr>
<td>Intercept</td>
<td>1</td>
<td>.48</td>
<td>7.04</td>
<td>.009</td>
</tr>
<tr>
<td>GPA Economics</td>
<td>1</td>
<td>.01</td>
<td>0.21</td>
<td>.649</td>
</tr>
<tr>
<td>GPA Mathematics</td>
<td>1</td>
<td>.05</td>
<td>0.72</td>
<td>.398</td>
</tr>
<tr>
<td>GPA Dutch</td>
<td>1</td>
<td>.60</td>
<td>8.78</td>
<td>.004</td>
</tr>
<tr>
<td>TMT</td>
<td>2</td>
<td>.29</td>
<td>4.23</td>
<td>.017</td>
</tr>
<tr>
<td>Error</td>
<td>120</td>
<td>.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes. $^\text{A}$: Economic literacy has been narrowed down to students’ understanding of the microeconomic concept market as measured by standardized gain scores (= posttest score minus pretest score on the knowledge test divided by the maximum possible improvement due to the pretest score) on the knowledge test; GPA = grade point average on a scale ranging from 1 (lowest possible score) to 10 (highest possible score); TMT = research condition (experiment participation, video observation, or control). $R^2=.22$, Adj.$R^2=.19$.

2.5.2  INTERACTIONS, COMMUNICATION, AND EXPERIENCES

As students in the experiment participation condition seemed to have gained more knowledge than students in the video observation condition, the interactions and communication among students and their teacher in these conditions were analyzed. In Figure 2.1 general findings are presented.
Notes. Vertical axis: Percentage of lesson time in which a particular type of talk is observed; Horizontal axis: Type of research condition; Classroom talk labels based on Alexander (2004); t-s = teacher-student dialogue, s-s = student-student dialogue.

As can be observed from Figure 2.1, rote and recitation talk were almost equally present in both conditions. The need to instruct what students should do and how they should do it was more prominent in the experiment participation condition (26% of the lesson time) than in the video observation condition (17% of the lesson time). No explicit discussions were detected.

In the video observation condition, in which 29% of the lesson time was devoted to teacher-student dialogues, teachers barely used the observations made by students during the debriefing of the classroom activities. They generally accepted short student answers and did not frequently pass these on to other students. These dialogues could be characterized by their disputational and cumulative nature (cf. Mercer, 1995; Wegerif, 2001). Students seemed not challenged to provide explanations for their findings. Hence, dialogues in this condition seemed to converge to an initiation, response, and evaluation-sequence – an approach that has often been witnessed in more traditional economics classes (cf. Mercer, 1995). In the experiment participation condition, teacher-student dialogues only took about 9% of the lesson time, mainly...
during the teacher-led debriefing of the activities. In this phase, the talk concerned the interactions and the outcomes of an economic classroom experiment in relation to related economic concepts. Teachers often started by asking closed questions which they addressed to individuals. At first, this seemed consistent with an initiation, response, and evaluation sequence. However, dialogues gradually opened up when the teacher continued along the student answers, for example by asking the students to link their own experiences in the economic classroom experiment to the concept of marginal productivity. Students were encouraged to provide explanations, and to ask questions (cf. Mason, 2001). Passing questions from one student to another, however, and asking students to react on each other was barely observed. This indicates the cumulative nature of student-teacher talk in this condition (cf. Wegerif & Mercer, 1997).

Hardly any student-student talk is noticed in the video-condition (5% of the lesson time). The nature of the student-student talk in this condition could be depicted as sharing observations and, slightly, elaborating on each other’s observations. In the experiment participation condition, not only much more student-student talk was observed (about 17% of the lesson time), but also the nature of this talk differed. Talk amongst students considered their own performance. Moreover, students were encouraged to talk with each other about their ideas. The students talked about how to behave in the experiment and on developing performance strategies. In the video observation condition, students more prominently talked about the output of the observed experiments.

Furthermore, the learner reports of the students indicated that the subjective learning experiences between students differ between conditions (see Table 2.5). These self reported experiences by the students may gain further insight in some of the benefits and drawbacks of each of the three research conditions.
Table 2.5 Main Observations from the Learner Reports

<table>
<thead>
<tr>
<th>The students report on</th>
<th>Experiment Participation Condition</th>
<th>Video Observation Condition</th>
<th>Control Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>learning economic concepts</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How markets work in real life, e.g., supply and demand, and negotiating prices</td>
<td>7 (.23)</td>
<td>9 (.22)</td>
<td>4 (.11)</td>
</tr>
<tr>
<td>Supply and demand in relation to the theoretical economic concept “market”</td>
<td>0</td>
<td>7 (.17)</td>
<td>15 (.42)</td>
</tr>
<tr>
<td>Combining theory with practice</td>
<td>7 (.21)</td>
<td>6 (.14)</td>
<td>0</td>
</tr>
<tr>
<td>The cumulative nature of supply and demand lines in graphs</td>
<td>0</td>
<td>0 (.19)</td>
<td></td>
</tr>
<tr>
<td>How to draw graphs and interpret tables that represent markets</td>
<td>1 (.06)</td>
<td>1 (.04)</td>
<td>7 (.24)</td>
</tr>
</tbody>
</table>

(Continued)
Table 2.5  Main Observations from the Learner Reports
(Continued)

<table>
<thead>
<tr>
<th>The students report on</th>
<th>Experiment Participation Condition</th>
<th>Video Observation Condition</th>
<th>Control Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>the learner him-/herself</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Being a good negotiator</td>
<td>6 (.20)</td>
<td>3 (.08)</td>
<td>2 (.06)</td>
</tr>
<tr>
<td>Having good plane building capacities</td>
<td>9 (.30)</td>
<td>1 (.03)</td>
<td>0</td>
</tr>
<tr>
<td>Being good in watching and interpreting videos or tables/graphs</td>
<td>0 (.15)</td>
<td>6 (.15)</td>
<td>1 (.03)</td>
</tr>
<tr>
<td>Being good at drawing or interpreting graphs and tables in general</td>
<td>0 (.15)</td>
<td>6 (.15)</td>
<td>7 (.21)</td>
</tr>
<tr>
<td>Feeling better prepared for future educational levels</td>
<td>2 (.06)</td>
<td>3 (.07)</td>
<td>11 (.31)</td>
</tr>
<tr>
<td>Previously thought the learning activities would be less interesting than these turned out to be</td>
<td>10 (.36)</td>
<td>12 (.29)</td>
<td>7 (.19)</td>
</tr>
</tbody>
</table>

Notes. Absolute number (and fraction of within-group total) of similar student answers within each condition; not every student answered all questions, therefore, similar absolute numbers of answers within each condition might result in different fractions in this table. Table is inspired by a framework by De Groot (1980).

With respect to gaining understanding of economic concepts, Table 2.5 shows that mainly students in the experiment participation condition and the video observation condition brought up the relationship between theory and applications in the real world and combining theory with practice, whereas primarily students in the control condition reported on the theoretical and
technical representation of supply and demand in graphs and tables. Furthermore, as can be seen in Table 2.5, with respect to learning about themselves, the control condition seems to have triggered student confidence in feeling prepared for future educational levels. Students in the control condition and the video observation condition more frequently reported feeling able to perform “traditional” economics skills, such as drawing graphs and interpreting tables, whereas mainly students in the experiment participation condition described skills regarding “hands-on” learning experiences, such as negotiating prices. Hence, each research condition seems to have triggered a distinctive set of perceived learning outcomes by the students.

2.6 DISCUSSION AND CONCLUSION

The current study aimed at investigating the effects of two distinct versions of economic classroom experiments on the economic literacy of secondary school students. In the first research condition, all students participated in a series of four microeconomic classroom experiments, whereas in the second, students observed videos showing peers engaged in a similar sequence of four experiments. The outcomes of these interactive and constructive research conditions were compared to a control condition in which students attended standard lessons and solved exercises.

The results showed that the participation in and the observation of microeconomic classroom experiments seem more beneficial for gaining knowledge of microeconomic concepts when compared to a non-experimental control condition. Furthermore, students in the interactive experiment participation condition gained more knowledge of economic concepts than students in the constructive video observation condition. Together, these findings indicate that the interactive experiences from participating in economic classroom experiments increase standardized microeconomic knowledge gains to a larger degree than does a constructive observation of these experiments. These findings are in line with Chi (2009), who hypothesizes that interactive learning may be superior to constructive learning.
To explore possible causes of these differences in more detail, the interactions and communication that took place in the experiment participation and the video observation condition were compared and characterized. Student-student interactions seemed more prominent in the experiment participation condition than in the video observation condition. It was also noticed that teachers in the video observation condition mainly used an initiation, response, and evaluation-pattern during their interactions with the students. Although this procedure might have helped students to remember facts and concepts, it is questionable to which extent such an approach would be beneficial for acquiring knowledge needed for solving problems or transferring knowledge to new contexts (cf. Mayer, 2002). The strategies needed for inducing dialogues among students, however, were not discussed in detail with the teachers before the research started. Therefore, the future training of teachers may stress explicitly the value of student answers, experiences, and observations as starting points for learning dialogues. An increased attention to the merits of dialogue and the use of ground rules for communication (e.g., Mercer, 1995; Wegerif, 2001) to the training and the teaching protocols may equip teachers with ideas how to create a classroom climate in which students are encouraged to use dialogues in which they can share knowledge together and will challenge each other’s ideas critically. The student self-reports indicated that students in the experiment participation condition valued their hands-on learning experiences, whereas students in the constructive video observation and active control condition more frequently reported having learned to perform “traditional” economics skills, such as drawing graphs and interpreting tables. The experiences encountered and reported by the students in the experiment participation condition may provide educators with important indications regarding the elements that may foster student motivation, such as the use of hands-on experiences during the teaching/learning activities.

The current study globally explored and described the interactions and communication that took place in the research conditions. Future research could elaborate on this aspect in more
detail, for example by using the current findings in combination with literature regarding interactions in collaborative inquiry learning environments (e.g., Kumpulainen & Mutanen, 1999; Stegmann, Weinberger, & Fischer, 2007) to formulate and test research hypotheses regarding the interactions, dialogues, and behavior of the students.

Due to practical reasons, whole classes are assigned to conditions. This is considered an unavoidable caveat in natural settings such as these, although it might also weaken the internal validity of the present study. To circumvent this concern, future, larger scaled research could apply the matching principle, where equivalent groups are assigned to conditions. This would require learning prerequisites data to be available beforehand.

In the present study, microeconomic knowledge gains were measured by means of a direct posttest only. Future research may therefore investigate knowledge retention by means of a delayed posttest as well. Chapter 3 will elaborate on this idea. Further studies could also incorporate measuring economic reasoning and transfer, both of which are considered important components of economic literacy. These components will be dealt with in Chapters 3, 4, and 6 of this thesis.

To enhance economic reasoning and transfer, redesigned teaching/learning materials should, for instance, encourage students to talk with each other in-depth, and encourage teachers to take student observations as a starting point, to pass questions on to other students, and not to accept short student answers (cf. Osborne, 2010). This may further support exploratory talk in the classroom. Chapter 3 will elaborate on this idea.

The present study shows that participating in economic classroom experiments seems beneficial for the knowledge acquisition of microeconomic concepts of secondary school students. It may be useful to compare the current findings to future studies to be executed in other (sub)disciplines, such as financial literacy education or chemistry.
REFERENCES


CHAPTER 3
CHAPTER 3

EFFECTS OF ECONOMIC CLASSROOM EXPERIMENTS ON ECONOMIC KNOWLEDGE AND REASONING IN SECONDARY EDUCATION

ABSTRACT
This study explores whether and how economic classroom experiments may enhance the economic knowledge and the reasoning ability of secondary school students. Economic classroom experiments are controlled interactive learning exercises by means of which students can learn to think as economists. Economic reasoning is conceptualized as the ability to identify a correct cause-and-effect relationship between variables. Students formulate an initial hypothesis by indicating two main variables from an economic context, determining associations between these, and formulating possible explanations. Subsequently, students test their hypothesis and try to establish the accuracy of their initial ideas. From the economic classroom experiments used in the study, students have to derive key variables, determine how these variables are related, and provide explanations. The goal of the study is to investigate whether actually participating in economic classroom experiments \( (n = 36) \) is more beneficial to learning than either watching others perform economic classroom experiments \( (n = 27) \) or merely analyzing the data produced by other students within such experiments \( (n = 45) \). Contrary to expectations, students who observe experiments and students who analyze experimental data show higher and sustained gains in their knowledge of economic concepts than students who participate in the experiments. Moreover, experiment participation turns out to be less beneficial for the reasoning-ability of students than video observation and data analysis. Possible explanations for these findings are discussed.

KEY WORDS
Economic classroom experiments, economic reasoning, inquiry learning, secondary education.

JEL-CLASSIFICATION
A21, D00.

SUBMITTED
3.1 INTRODUCTION

A primary goal of economics in secondary education is to provide students with the fundamentals needed for becoming economically literate (e.g., Siegfried & Meszaros, 1997; Siegfried et al, 2010). As pointed out in Chapter 1, economic literacy encompasses gaining understanding of economic concepts, setting up economic reasoning, and transferring economic textbook situations across contexts. The focus of the present study is economic reasoning, however, as knowledge of economic concepts can be regarded a prerequisite for economic reasoning, this aspect of economic literacy is addressed in this study as well.

The importance of economic reasoning for the economic literacy of students has been addressed by Arnold (2005) and CoLander (2009), and is also highlighted in several national economics curricula. For example, the US Voluntary National Content Standards in Economics intend “to help students learn crucial reasoning and decision-making skills that will serve them well all of their lives” (Siegfried et al., 2010, p. ix). Comparable goals can be found in European curriculum standards, such as in the United Kingdom (Department for Education [DfE], 2014), the German province of Hamburg (Stolze, 2011), and the Netherlands (Teulings et al., 2005).

Paradoxically, curriculum materials do not necessarily reflect the importance of economic reasoning conveyed by the national standards. In the Netherlands, for example, economic textbooks ask students to provide arguments and explain their answers (Adriaansen et al., 2008), write down a sentence that accurately connects several economic concepts (Duijm & Gorter, 2009), place economic phenomena in a correct cause-and-effect-sequence (Bielderman, Rupert, & Spierenburg, 2009), or write a letter to a newspaper editor in which causes, effects, and a proper argumentation regarding a given case have to be addressed (Bielderman et al., 2009). However, these materials do not seem to offer explicit information or strategies that support the acquisition of reasoning skills. Moreover, although the national standards aim at enhancing economic reasoning skills, a recent evaluation report on the national
examinations of secondary school economics in the Netherlands indicates that economic reasoning seems rather difficult to students (Welp, Dieteren, & Kneppers, 2009).

Given the importance of economic reasoning for the economic literacy of students on the one hand, and the lack of explicit guidelines on how to promote reasoning skills during class on the other, the present study explores how economic reasoning can be supported in secondary education. In section 3.2 the process of economic reasoning and tools to support it are described. Section 3.3 describes the research method. The results are presented in section 3.4. These findings are discussed and elaborated on in section 3.5.

3.2 ECONOMIC REASONING
Reasoning is considered a cornerstone of constructing new understanding (Osborne, 2010). People use reasoning in both formal and informal settings. In everyday-life situations, for example when buying a new mobile phone, one usually considers several arguments before reaching a decision. Hence, at the heart of reasoning is the skill to generate and evaluate proper arguments (Kuhn, 1992; Zohar & Nemet, 2002). Reasoning in formal educational settings might involve even more highly complex skills such as using deductive logic and induction to generate and test hypotheses (e.g., Osborne, Simon, Christodoulou, Howell-Richardson, & Richardson, 2013; Zimmerman, 2000). Although the development of such skills have for long been thought to mainly emerge during adulthood, more recent research shows that also adolescents and children can learn to apply its basic elements (e.g., Sodian & Bullock, 2008; Zimmerman, 2000).

Within education, reasoning has been studied in several fields, such as history education and the physical sciences. With regard to history education, Van Boxtel and Van Drie (2009) describe a research focus on teaching/learning methods and elaborate on the use of student reasoning in socio-constructivist teaching/learning activities. In their view, educators should create opportunities for students to set up reasoning in dialogue with fellow students and their
teacher (Van Boxtel & Van Drie, 2009). Sharing explanations that are relevant to the problem at hand, building on each other’s ideas, providing arguments, and trying to reach agreement have been found to positively affect the reasoning skills of pupils (e.g., Kneser & Ploetzner, 2001; Wegerif, Mercer, & Dawes, 1999; Mercer, Dawes, Wegerif, & Sams, 2004). Introducing ground rules for communication can support the application of this so called “exploratory talk” (e.g., Mercer, 1995; Wegerif, 2001). One of these ground rules says that students should always provide arguments for the statements they make (e.g., Wegerif et al., 1999). This might prepare students better for engaging in coherent learning dialogues with each other (e.g., Roschelle & Teasley, 1995). Requiring students to exchange their initial ideas together first may not only be helpful for comparing their own ideas regarding the open-ended problems with which they are provided, it may also be helpful to reduce the free riding behavior of students during the subsequent joint classroom conversation. This may be why Van Boxtel and Van Drie (2009) suggest to use a combination of dialogues in pairs with plenary classroom sessions.

Notwithstanding the relevance of previous research in history education, thus far, student reasoning seems to have been studied prominently in the field of physical science education (Osborne et al., 2013). Herein, focus has been paid to actively engaging students in scientific reasoning processes through inquiry approaches to learning (e.g., Lazonder, Hagemans, & De Jong, 2010; Löhner, Van Jooldingen, Savelsbergh, & Van Hout-Wolters, 2005; Zion, Michalsky, & Mevarech, 2005). Hence, students “do science” to learn about the knowledge content of science. They are introduced, for example, into a specific context from which they can identify possible variables and formulate hypotheses. Subsequently, students are asked to test these hypotheses, for example by executing experiments or by analyzing data. Finally, students are given opportunities to reformulate their initial hypotheses with the help of the evidence that emerged during class, and to disseminate their findings (e.g., Kuhn, Black, Keselman, & Kaplan, 2000).
Various supports have been developed to assist students during their inquiries. One example is a digital scratchpad that aims to help students in formulating hypotheses by offering a pre-set list of variables and possible relations between these variables (Van Joolingen & De Jong, 1991; Joolingen & De Jong, 1991, 1997; Van Joolingen, 1999). More explicit support for hypothesis generations can be given in a so-called proposition table that contains a series of full-fledged hypotheses which the students can test (Gijlers & De Jong, 2009).

Hitherto, examples from history and physical sciences have been brought forward to illustrate aspects of reasoning in educational settings. But what typifies economic reasoning in secondary education? As economics can be characterized by the predominant relational structure of its underlying concepts (Armento, 1987), knowing the definition of an economic concept is a first step in identifying its relationship with other concepts (cf. Armento, 1987; Fagin, Halpern, Moses, & Vardi, 1995). Relations between economic concepts within the secondary school subject of economics can be characterized by their causal nature (e.g., Amagir, Kneppers, & Westenberg, 2013). Causality involves identifying the relationship between a certain cause and an associated effect (Jonassen & Ionas, 2008). An example may elucidate this idea. Secondary school students have to be introduced to basic mechanisms regarding demand and supply. An increasing price of train tickets might, ceteris paribus, result in a decrease in the quantity demanded of train tickets. In this example, two variables are associated with each other. Causality describes that a certain cause (a rising price) is negatively associated with and precedes a particular effect (a decrease in quantity demanded). To explain why causality operates this way, students will need additional knowledge of accompanying process mechanisms (Jonassen & Ionas, 2008). This is where principles come into play: General information concerning theories, regularities, and relations within a domain (Eiriksdottir & Catrambone, 2011). Various collections of principles regarding the domain of economics can be found in the literature (e.g., Frank & Bernanke, 2004; Mankiw, 2011; Schug & Western,
2000a; Schug & Western, 2000b; Siegfried et al., 2010). Out of these, Mankiw (2011) presumably provides the most concise, recent, and well established list (see Box 3.1).

**Box 3.1  Ten Economic Principles**

<table>
<thead>
<tr>
<th>How People Make Decisions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1: People Face Trade-offs</td>
<td></td>
</tr>
<tr>
<td>2: The Cost of Something Is What You Give Up to Get It</td>
<td></td>
</tr>
<tr>
<td>3: Rational People Think at the Margin</td>
<td></td>
</tr>
<tr>
<td>4: People Respond to Incentives</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How People Interact</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>5: Trade Can Make Everyone Better Off</td>
<td></td>
</tr>
<tr>
<td>6: Markets Are Usually a Good Way to Organize Economic Activity</td>
<td></td>
</tr>
<tr>
<td>7: Governments Can Sometimes Improve Market Outcomes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How the Economy as a Whole Works</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>8: A Country’s Standard of Living Depends on Its Ability to Produce Goods and Services</td>
<td></td>
</tr>
<tr>
<td>9: Prices Rise When the Government Prints Too Much Money</td>
<td></td>
</tr>
<tr>
<td>10: Society Faces a Short-Run Trade-off between Inflation and Unemployment</td>
<td></td>
</tr>
</tbody>
</table>

*Note. Source: Mankiw (2011).*

Applied to the train ticket example, the principle “people respond to incentives” might help students to provide an explanation for the negative relationship between price and quantity demanded: As prices can be regarded powerful incentives, increasing train ticket prices might force people to reconsider if they find it acceptable to pay more for these tickets, or whether they might better switch to a cheaper substitute, for example by buying bus tickets instead. Principles can thus be helpful in explaining the processes taking place between cause and effect (Eiriksdottir & Catrambone, 2011), and serve as “a frame of reference” (Morris & Rouse, 1985,
p. 705) that can assist students in constructing comprehensive mental models of the situation at hand (e.g., Barnett & Ceci, 2002; Duff & Barnard, 1990).

Although reasoning in real-world economic situations may involve consequential or covariational reasoning, Koslowski, Okagaki, Lorenz, and Umbach (1989) stress that the absence of covariation does not involve the nonexistence of causality per se, and, occasionally, the presence of covariation may be a result of coincidence. Overriding the covariations that are identified by the students in a specific situation, however, would require these students to reach multifaceted judgments. As the present study addresses basic economic reasoning skills within the context of secondary education, such a multifaceted judgment of covariation is considered unnecessarily complex. Therefore, the present study conceptualizes economic reasoning as the ability to identify a correct cause-and-effect relationship between variables. Students formulate an initial hypothesis by indicating two main variables from an economic context, determining associations between them, and formulating possible explanations (cf. Eiriksdottir & Catrambone, 2011; Jonassen & Ionas, 2008). Subsequently, students test this hypothesis and, by doing so, try to establish the accuracy of their initial ideas. This is why the nature of student reasoning in this study can be considered as hypothetico-deductive.

A domain specific approach to inquiry learning, in which students can apply such a hypothetico-deductive approach to economic reasoning, can be achieved by using experiments in the economics classroom (cf. Wentland, 2004). As described in Chapters 1 and 2, economic classroom experiments can be regarded as interactive teaching/learning exercises that aim at supporting a student’s comprehension of economics in an bottom-up way. Furthermore, the application of these experiments in a classroom setting may enable students to think as economists (cf. Haus, 2009).

Previous studies suggest that economic classroom experiments can be used in at least three ways. First, all students can participate as actors in the experiment. This has been done in most previous studies on economic classroom experiments (e.g., Cebula & Toma, 2002; Dickie,
Another way of using economic classroom experiments is by asking a group of students to observe the behavior of another group who are actually performing economic classroom experiments (Frank, 1997; Chapter 2). A third alternative is to ask students to analyze only the data emerging from economic classroom experiments, as posed by Cartwright and Stepanova (2012, p. 55): “It may be that participating in an experiment has less benefit than analyzing experimental data; if true, this would suggest that it is enough to have some data to work with (as is standard, for example, in statistics courses) and that the experiment itself is less necessary”. To the best of our knowledge, this suggestion has not been studied empirically yet.

As declarative knowledge of economic concepts can be considered a first step in identifying its relationship with other concepts, the present study addresses the extent to which economic classroom experiments contribute to gaining knowledge of economic concepts and to economic reasoning skills. The study consists of three conditions. Students in the experiment participation condition generate their own data by participating in economic classroom experiments, students in the video observation condition observe and record the output resulting from the behavior of other students who are engaged in experiments, and students in the data analysis condition study and analyze a given case with accompanying experimental data. Students will be provided with tools to support the reasoning and collaboration processes. These aim at reducing the cognitive short term memory load of the students (cf. Kirschner, Sweller, & Clark, 2006). The following research hypotheses are investigated:

Hypothesis 1: Participation in economic classroom experiments improves student knowledge of economic concepts to a greater extent than does the observation of economic classroom experiments or the analysis of experimental data.
Hypothesis 2: Participation in economic classroom experiments improves economic reasoning to a greater extent than does the observation of economic classroom experiments or the analysis of experimental data.

3.3 METHOD
3.3.1 PARTICIPANTS
Via the professional network of the investigators, schools for lower general secondary education were recruited. These were randomly assigned to the experiment participation condition (2 classes, 53 students), the video observation condition (1 class, 29 students), and the data analysis condition (2 classes, 58 students). Before the research started, the students had acquired quite similar knowledge of basic economic principles as they were enrolled in their first year of formal economics education. The research took place between October and November 2013 and only one condition per school was applied. All demographic data (age, sex, and grade point averages (GPAs) for the school subjects of economics, mathematics, and Dutch language) were collected from official school records (cf. Maxwell & Lopus, 1994). To rule out possible differences between groups concerning the initial student motivation for the school subject of economics, a carefully modified version of the validated Attitude Scale towards Mathematics (ASM, Martinot, Kuhlemeier, & Feenstra, 1988) was administered. In this questionnaire, the school subject “mathematics” was replaced with “economics”. On a 4-point Likert scale, ranging from “totally agree” to “totally disagree”, students indicated their agreement with testimonials such as: “I consider economics to be a fun school subject”. Exploratory factor analysis indicated that the four constructs of pleasure, no fear/difficulty, interest/devotion, and profit/relevance were measured by this version of the ASM. Each factor showed a good internal consistency (as ranging from .70 to .87). Due to a lack of available student-specific data beforehand, post-hoc matching was applied to further balance the composition of student characteristics (age, gender, GPAs, and ASM-scores) among conditions.
This resulted in the inclusion of 108 students, on average aged 14.3 years (SD=0.53) of which 62 (57.4%) were female. Table 3.1 shows summary statistics concerning demographics and learning preconditions.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total All Conditions $N=108$</th>
<th>Experiment Participation Condition $N=36$</th>
<th>Video-Observation Condition $N=27$</th>
<th>Data-Analysis Condition $N=45$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>14.3 (0.53)</td>
<td>14.2 (0.49)</td>
<td>14.3 (0.45)</td>
<td>14.5 (0.59)</td>
</tr>
<tr>
<td>Female</td>
<td>62 (57.4)</td>
<td>18 (50.0)</td>
<td>18 (66.7)</td>
<td>26 (57.8)</td>
</tr>
<tr>
<td>GPA Economics</td>
<td>6.7 (1.26)</td>
<td>7.1 (1.06)</td>
<td>6.4 (1.11)</td>
<td>6.6 (1.44)</td>
</tr>
<tr>
<td>GPA Mathematics</td>
<td>6.9 (1.17)</td>
<td>6.8 (1.27)</td>
<td>6.8 (0.87)</td>
<td>7.1 (1.25)</td>
</tr>
<tr>
<td>GPA Dutch language</td>
<td>6.3 (0.97)</td>
<td>6.4 (0.86)</td>
<td>6.2 (0.72)</td>
<td>6.3 (1.19)</td>
</tr>
<tr>
<td>ASM Pleasure</td>
<td>23.9 (4.61)</td>
<td>23.8 (4.70)</td>
<td>24.1 (5.42)</td>
<td>23.8 (3.91)</td>
</tr>
<tr>
<td>ASM No fear / difficulty</td>
<td>26.2 (3.78)</td>
<td>26.5 (3.19)</td>
<td>26.5 (4.13)</td>
<td>25.8 (4.02)</td>
</tr>
<tr>
<td>ASM Interest / devotion</td>
<td>18.7 (3.79)</td>
<td>19.0 (3.54)</td>
<td>18.7 (4.14)</td>
<td>18.4 (3.83)</td>
</tr>
<tr>
<td>ASM Profit / relevance</td>
<td>26.5 (3.49)</td>
<td>26.3 (3.09)</td>
<td>26.9 (3.13)</td>
<td>26.5 (4.07)</td>
</tr>
</tbody>
</table>

*Notes.* All data are reported [mean (SD)], except for Female: [Number of female students (%)]; Age: The age of the respondent; Female: Number of female students; GPA: Grade point average on a scale ranging from 1 (lowest possible score) to 10 (highest possible score); ASM: Student scores on the four domains of the adapted version of the Attitude Scale towards Mathematics (Martinot et al., 1988).
Although cross tabulations indicated sex to be not equally distributed between conditions, ANOVAs showed no further significant mean differences between the three research conditions. Hence, randomization and post-hoc matching were successful.

3.3.2 MEASURES

3.3.2.1 ECONOMIC KNOWLEDGE AND REASONING

The microeconomic concept *market*, including subtopics such as supply, demand, equilibrium, and effects of government interference, were selected as subject matter for the interventions. To measure student *knowledge of these economic concepts*, a pretest, a direct posttest, and a delayed posttest were administered. Test items in the three tests addressed identical content knowledge dimensions and cognitive process dimensions (cf. Krathwohl, 2002). However, to eradicate possible student improvements by memorizing test questions, items in the three tests were not literally identical. Each test consisted of 31 multiple choice questions regarding the topic *market*, and included four possible answers. A sample question is: “Given these demand-and-supply curves, please indicate the correct combination of consequences when the government introduces a price floor of €4 per product”. Each correct answer was rewarded one point. Although reliability analysis showed a poor internal consistency of the questions regarding knowledge of economic concepts in the pretest ($\alpha=.57$), there was a good consistency in both the posttest ($\alpha=.75$) and the delayed posttest ($\alpha=.78$). It would be premature to judge the reliability of the knowledge test based on the pretest only. The lower alpha found here might be attributable to floor effects in the test or might even reflect “random guessing behavior” of the students who have not been enrolled in the research conditions yet. These explanations seem in line with the good alphas that are found in both the posttest and the delayed posttest.

To measure *economic reasoning*, student performances on a pretest, a posttest, and a delayed posttest were assessed. The questions in each of these tests were not literally identical
for the same reasons as have been explained in the previous paragraph. The reasoning ability of the students was tested through three open questions, such as: “Predict what happens to the sales revenues of a manufacturer, when this manufacturer increases the price of a box that contains 20 small candles, from €1.20 to €1.50. Explain your answer carefully”. Each answer was awarded 0, 1, 2, or 3 points, as exemplified by Table 3.2:

<table>
<thead>
<tr>
<th>Points awarded</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No answer at all / a wrong answer</td>
<td>“I don’t know?!”</td>
</tr>
<tr>
<td>0</td>
<td>An answer without economic reasoning</td>
<td>“The sales revenues of the manufacturer will remain equal.”</td>
</tr>
<tr>
<td>+1</td>
<td>The identification of a correct cause and effect, as well as the direction of this relationship</td>
<td>“If the price of such a box rises by 30 cents, the sales revenues of the manufacturer will rise. This is because he receives extra revenues per box. And I assume that the number of boxes sold is not likely to decrease.”</td>
</tr>
<tr>
<td>+1</td>
<td>The provision of a correct economic principle explaining this effect</td>
<td>“The economic principle here is: people respond to incentives. However, it must be said that I think that a slightly higher price will not likely affect peoples candle-buying behavior that much.”</td>
</tr>
<tr>
<td>+1</td>
<td>The addition of possible alternatives</td>
<td>“Although I stated that the sales revenues of the manufacturer will rise as a result of the increased price per box of candles, it is also possible that his sales revenues will remain equal – or even fall. This might be due to the number of boxes sold. Perhaps, poor people will stop buying these boxes of candles if prices rise and switch to boxes produced by another and cheaper manufacturer.”</td>
</tr>
</tbody>
</table>

Note(s). -

Students could earn a maximum of 3 points per correct answer, hence 9 points in total. Answers were scored by two independent raters. To determine consistency among raters, an intra-class correlation coefficient was computed (two way mixed model, absolute agreement, single measures). It was found to be good: ICC = .88 (p < .001), 95% CI (0.804, 0.930). Disagreements
between raters were resolved by consensus. These disagreements occurred, for example, when students merely described an economic principle in their own words instead of writing it down literally.

3.3.2.2 CONVERSATIONS AND SELF-REPORTED EXPERIENCES

Qualitative process measures were employed to capture the reasoning processes of the students, as well as their personal learning experiences. These measures could elucidate the quantitative results of the study. To be able to trace the reasoning processes, the conversations of two randomly chosen pairs of students were captured via voice recorders during each lesson in each class. These recordings were transcribed and analyzed to check if and to what extent they incorporated (1) the application of the ground rules for communication, (2) the main elements of economic reasoning (identifying causes and effects, describing their relationship, and formulating an explanation), and (3) the use of economic principles by the students. Two raters independently scored the recordings using the software package Kwalitan 5.0 (Peters, 2000-2014). The intra-class correlation coefficient (two way mixed model, absolute agreement, single measures) indicated a good consistency among the raters: ICC=.90 ($p<.001$), 95% CI (0.590, 0.960).

In addition, so-called learner reports (De Groot, 1974) were administered to gain insight in how students experienced enrollment in their own research condition only. In these reports students completed sentences such as: “These lessons were useful for...” and: “These lessons helped me to show me that I am capable of...”. Unfortunately, the students’ self-reports from the video observation condition never arrived at the University’s mailbox. Hence, despite all efforts to retrieve them, these data are missing. All available student answers were printed on separate cards. Two independent raters, who were blind to conditions, sorted these cards and labeled them. They then discussed their labels, resolved disagreement by consensus, and calculated frequencies for each final label. The consistency among the raters [intra-class
correlation coefficient (two way mixed model, absolute agreement, single measures)] was found to be substantial: ICC=.72 (p<.001), 95% CI (0.720, 0.910).

3.3.3 RESEARCH DESIGN

Three research conditions were developed to investigate the main research question. All conditions aimed to increase the economic reasoning skills of students through economic classroom experiments as a domain specific form of inquiry learning. The first research condition was the “experiment participation condition”, in which all students participated in economic classroom experiments. In the second “video observation condition”, the students watched video recordings of peers who were performing economic classroom experiments. In the third “data analysis condition”, students were provided with cases and accompanying data sets containing the outcomes of economic experiments. Learning goals and assessment questions were identical in the three research conditions.

Students in all conditions were introduced to economic reasoning by their teacher. The teacher discussed an example with the students by addressing the following question: “Suppose your local outdoor swimming pool raises its entrance prices, starting in July, by one euro per person. According to you, what would happen then?” Then, all students received a reasoning tool, inspired by Van Joolingen and De Jong (1991, 1997) and Van Joolingen (1999), that introduced them to economic reasoning (Box 3.2).
Box 3.2  Reasoning Tool

<table>
<thead>
<tr>
<th>Variable 1</th>
<th>Direction-1</th>
<th>Variable 2</th>
<th>Direction-2</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;If&quot;</td>
<td>........</td>
<td>diminishes</td>
<td>........</td>
<td>because</td>
</tr>
<tr>
<td></td>
<td></td>
<td>remains</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>equal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>increases</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>increases</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>


This tool is a template that stimulated students to use general steps necessary for setting up economic reasoning: Identifying a variable as a cause, describing the direction of movement of that variable, identifying a variable as an effect, describing the direction of movement of that variable, and providing a possible explanation for the effect. A short list containing the relevant economic principles 1 to 7 from Box 3.1 was offered to the students as well. Students were asked to use these principles when explaining the processes taking place between cause and effect. Students were asked to write down their reasoning individually first, with the help of the reasoning tool (Box 3.2) and the list of economic principles (Box 3.1). After this, students sitting next to each other were paired by their teacher. They were asked to discuss their reasoning in pairs. To guide this collaborative exchange of ideas, the students were provided with a list that included ground rules for classroom communication (see Box 3.3). These rules were also carefully explained to them by their teacher. Finally, the teacher invited all students to participate in a plenary classroom session in which students were encouraged to share their reasoning, and others to provide feedback. During three lessons, this sequence was repeated.
Box 3.3 Ground Rules for Communication

1. If someone speaks, we listen to him or her
2. To not disturb others, we do not speak too loud with each other
3. We encourage each other to contribute to the discussion
4. We will share all information that is needed
5. Everyone tries to reach agreement with each other
6. We always provide arguments for the statements we make
7. No final decision is made before all arguments and alternatives have been discussed
8. Every group member agrees on the final outcome we reach in our group


The general lay-out of each of these lessons is as follows: The teacher introduces the topic and students formulate hypotheses. Then, students take part in the particular teaching/learning activities in their own research condition only. Students check their hypotheses based on their findings. They discuss these findings in pairs. Finally, there is a final debriefing with all students and the teacher during a plenary classroom session. The research conditions differed only with respect to the way in which data were required by the students. Students in the experiment participation condition played an economic classroom experiment, during which they themselves generated data. They recorded their own experimental outcomes on report sheets. Students in the video observation condition watched a video showing peers performing an economic classroom experiment. These students recorded the experimental outcomes of the observed experiment participants. Finally, students in the data analysis condition were provided with a case and a report sheet displaying experimental data. Table 3.3 illustrates the teaching/learning activities in each of the three research conditions in more detail.
Table 3.3  
Teaching/Learning Activities in the Three Research Conditions

<table>
<thead>
<tr>
<th>Lesson Number</th>
<th>Experiment Participation Condition</th>
<th>Video Observation Condition</th>
<th>Data Analysis Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Individual students have to place bids in an English and in a Dutch auction, in both of which a can of Coca Cola can be bought. They experience the negative relationship between price levels and demand. They collect data, calculate, and draw graphs of demand behavior.</td>
<td>Students observe a video in which individual students place bids in an English and in a Dutch auction, in both of which a can of Coca Cola can be bought. They collect data, calculate, and draw graphs of demand behavior.</td>
<td>Students are provided with a case and data regarding people’s willingness to pay for a specific product. They calculate and draw graphs of demand behavior.</td>
</tr>
<tr>
<td>2</td>
<td>Groups of students fold airplanes out of sheets of paper. They experience that adding extra employees without adding extra other production factors (such as tables or pens) will first increase, but finally decrease production per worker.</td>
<td>Students observe a video in which groups of students are folding paper airplanes. They observe, discuss, calculate, and visualize that adding extra employees without adding extra trucks or tools will first increase, but finally decrease production per worker.</td>
<td>Students are provided with a case and data regarding productivity. They calculate, draw, and discuss graphs on increasing and decreasing productivity.</td>
</tr>
<tr>
<td>3</td>
<td>Students buy and sell virtual apples in a market environment. They negotiate and seek to reach agreement on prices. Students experience prices to converge towards equilibrium over several rounds. Additionally, a price floor will be set. Students experience what happens to the behavior of (certain) buyers, sellers, and market prices as a result of this price floor.</td>
<td>Students observe a video in which other students buy and sell virtual apples in a market environment, thereby negotiating and seeking to reach agreement on prices. After several rounds, a price floor will be set. Students observe and calculate individual earnings of the students in the video and notice prices to converge towards equilibrium over several rounds. They compare pre and post price floor situations.</td>
<td>Students are provided with a case and data regarding market behavior. They draw supply and demand curves accordingly, and compute the market equilibria in pre- and post price floor situations.</td>
</tr>
</tbody>
</table>

Note. a The economic classroom experiments that were used are based on specific literature: Lesson 1: “Demand for Coca Cola” (Grol, 2009); Lesson 2: “Measuring productivity” (Bergstrom & Miller, 1997; 1999); Lesson 3: “The apple market” (Bergstrom & Miller, 1997; 1999).
3.3.4 PROCEDURE
To reduce experimenter-demand-effects, students were taught and assessed by their own teacher (e.g., Zizzo, 2008). All teachers were provided with lesson plans that covered all lessons. These plans consisted of learning goals, a verbal instruction, explicit debriefing guidelines, and all student materials. Before the research started, all teachers received individual instructions from the principal investigator within the context of their own schools. This training familiarized the teachers with the teaching/learning activities that they would perform during the study. All materials were handed out and elaborated to assure that everyone would be aware, amongst others, which documents had to be handed out to the students and how the data should be collected and handed-in. Especially, teachers were instructed that they should encourage their students to set up their own reasoning. Therefore, teachers were asked to refrain from providing answers. Instead, they should support their students to think aloud and discuss their lines of reasoning or findings together. This is why the ground rules for communication (see Box 3.3) were discussed and why all teachers were asked to use these rules during class as well15. Students filled out the knowledge and reasoning pretests and the ASM-questionnaire in the first lesson. In lessons 2-4, students participated in the teaching/learning activities in one of the three research conditions only. Students filled out the knowledge and reasoning posttests and the learner reports in lesson five. Six weeks later, the retention test was administered during a final lesson.

3.4 RESULTS
3.4.1 KNOWLEDGE OF ECONOMIC CONCEPTS
The first research hypothesis regarded the effects of participation in economic classroom experiments on a student’s knowledge of economic concepts. Student scores on the three knowledge tests (pre, post, and retention) are presented in Table 3.4.
Table 3.4  
Student Scores on Knowledge Tests

<table>
<thead>
<tr>
<th>Knowledge Scores</th>
<th>Total All Conditions N=108</th>
<th>Experiment Participation Condition N=36</th>
<th>Video Observation Condition N=27</th>
<th>Data Analysis Condition N=45</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>17.16 (3.82)</td>
<td>16.66 (3.59)</td>
<td>18.24 (4.29)</td>
<td>16.86 (3.62)</td>
</tr>
<tr>
<td>Posttest</td>
<td>20.22 (4.40)</td>
<td>18.52 (5.38)</td>
<td>22.00 (2.31)</td>
<td>20.50 (4.08)</td>
</tr>
<tr>
<td>Retention test</td>
<td>18.99 (4.99)</td>
<td>16.00 (6.06)</td>
<td>21.08 (3.50)</td>
<td>20.19 (3.43)</td>
</tr>
</tbody>
</table>

Note. All data are reported [mean (SD)].

A mixed between-within subjects analysis of variance was conducted to compare the knowledge test scores across the three time periods. There was a significant interaction between research condition and time, Wilks’ lambda=0.873, $F(4,178)=3.13$, $p=0.016$, $\eta^2=0.07$. There was also a significant main effect for time, Wilks’ lambda=0.680, $F(2,89)=20.985$, $p<0.001$, $\eta^2=0.32$. The main effect comparing the three conditions was significant, $F(2,90)=7.94$, $p<0.001$, $\eta^2=0.15$, suggesting differences in knowledge scores between the three conditions. The research condition by time interaction effect was analyzed using a simple main effects analysis. Condition affected student scores at posttest, $F(2,90)=4.89$, $p=0.010$, and retention test, $F(2,90)=10.92$, $p<0.001$, however, not at pretest, $F(2,90)=1.40$, $p=0.251$. The significant main effects of condition were further analyzed by pairwise comparison without further adjustments. At posttest, students in the video observation condition ($M=22.00$, SE=0.76) performed better than students in the experiment participation condition ($M=18.52$, SE=0.75, $p=0.003$). At retention test, students in the data analysis condition ($M=20.19$, SE=0.75) showed higher knowledge scores than students in the experiment participation condition ($M=16.00$, SE=0.80, $p=0.010$).
Also students in the video observation condition (M=21.08, SE=0.91) performed better than students in the experiment participation condition (M=16.00, SE=0.80, p<.001). Hence, contrary to the first research hypothesis, experiment participation resulted in significant less knowledge gains than video observation or data analysis.

### 3.4.2 ECONOMIC REASONING

The second research hypothesis regarded the effects of participation in economic classroom experiments on the economic reasoning ability of students. Student scores on the three reasoning tests (pre, post, and retention) are presented in Table 3.5.

A mixed between-within subjects analysis of variance was conducted to compare the reasoning test scores across the three time periods. There were no significant interactions between research condition and time, Wilks’ lambda=0.910, F(4,178)=2.17, p=.077, $\eta^2=.05$, nor for time, Wilks’ lambda=0.984, F(2,89)=0.745, p=.478, $\eta^2=.02$. The main effect comparing the three conditions was significant, F(2,90)=35.02, p<.001, $\eta^2=.44$, suggesting differences in reasoning scores between the three conditions. Tukey post-hoc tests indicate that students in the data analysis condition gained higher reasoning scores than students in the experiment participation condition (M=0.69, SE=0.17, p<.001). Students in the video observation condition gained higher reasoning scores than students in the experiment participation condition (M=1.53, SE=0.18, p<.001). Taken together, contrary to the second research hypothesis, experiment participation was significant less beneficial for economic reasoning than were video observation and data analysis.
3.4.3 CONVERSATIONS AND SELF-REPORTED EXPERIENCES

All recorded student conversations during class as well as the self-reported student experiences were analyzed to elucidate these findings. Table 3.6 provides an overview of the application of ground rules by the students, their use of the main reasoning elements, and the presence of economic principles in the student dialogues in which they reasoned about their hypotheses and findings.

Students in all conditions encouraged each other explicitly to contribute to the dialogues and to reach agreement with each other. The students in the experiment participation condition seemed to persuade each other to share information a little more frequently than students in the other two conditions. The students in the data analysis condition seemed to support each other slightly more frequently to provide arguments for their answers than students in the other two conditions. Students in the data analysis condition mentioned causes, effects, and explanations during class more frequently than students in the other two conditions. Hence, the observed number of reasoning elements is larger for these students than for students in the other conditions.

Table 3.5  
Student Scores on Reasoning Tests

<table>
<thead>
<tr>
<th>Reasoning Scores</th>
<th>Total All Conditions N=108</th>
<th>Experiment Participation Condition N=36</th>
<th>Video Observation Condition N=27</th>
<th>Data Analysis Condition N=45</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>1.17 (1.00)</td>
<td>0.67 (0.75)</td>
<td>2.04 (0.87)</td>
<td>1.01 (0.92)</td>
</tr>
<tr>
<td>Posttest</td>
<td>1.30 (1.36)</td>
<td>0.41 (0.45)</td>
<td>2.34 (1.73)</td>
<td>1.38 (1.06)</td>
</tr>
<tr>
<td>Retention test</td>
<td>1.19 (1.03)</td>
<td>0.55 (0.43)</td>
<td>1.82 (1.33)</td>
<td>1.31 (0.87)</td>
</tr>
</tbody>
</table>

Note: All data are reported [mean (SD)].
Table 3.6 Comparison of Student Conversations

<table>
<thead>
<tr>
<th>Dialogues</th>
<th>Experiment Participation Condition</th>
<th>Video Observation Condition</th>
<th>Data Analysis Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Explicit application of ground rules</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Listening to speaker</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(10%)</td>
<td></td>
<td>(7.1%)</td>
</tr>
<tr>
<td>Not speaking too loud</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(5%)</td>
<td></td>
<td>(7.1%)</td>
</tr>
<tr>
<td>Encouraging contributions</td>
<td>8</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>(40%)</td>
<td>(75%)</td>
<td>(28.7%)</td>
</tr>
<tr>
<td>Sharing information</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(15%)</td>
<td>(8.3%)</td>
<td>(7.1%)</td>
</tr>
<tr>
<td>Reaching agreement</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(15%)</td>
<td>(16.7%)</td>
<td>(21.4%)</td>
</tr>
<tr>
<td>Providing arguments</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(5%)</td>
<td></td>
<td>(14.4%)</td>
</tr>
<tr>
<td>Discussing arguments</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(5%)</td>
<td></td>
<td>(7.1%)</td>
</tr>
<tr>
<td>Agreement on group outcome</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(5%)</td>
<td></td>
<td>(7.1%)</td>
</tr>
<tr>
<td>Reasoning elements (#)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cause and direction</td>
<td>4</td>
<td>2</td>
<td>11</td>
</tr>
<tr>
<td>Effect and direction</td>
<td>5</td>
<td>3</td>
<td>11</td>
</tr>
<tr>
<td>Explanation</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Economic principles (#)</td>
<td>0</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>

Notes. Application of ground rules is reported number (% of total); #: Number. All numbers and percentages are calculated as averages per lesson.

The use of economic principles in the classroom conversations can be illustrated by two examples. Box 3.4 illustrates how students in the video observation condition encourage each other to come up with the principle *people face trade-offs* in a conversation regarding decreasing prices.
Box 3.4: Transcript from the Video Observation Condition

| Student-A: | \textit{The price decreases...} |
| Student-B: | \textit{... hence, the more people are willing to buy it, because they don’t want to spend much money on it.} |
| Student-A: | \textit{Which economic principles come into play here?} |
| Student-B: | [laughing] \textit{Yeah...} |
| Student-A: | \textit{Come on... Which economic principles come into play here? ... Come on... Which economic principles exist?} |
| Student-B: | \textit{Ehm...} |
| Student-A: | \textit{Come on... Here is a list... Look... People face trade-offs.} |

A similar way of using economic principles appeared in the dialogues that were recorded in the data analysis condition. However, not any use of economic principles was detected in the recorded dialogues of students in the experiment participation condition. The appearance of reasoning in the latter condition is illustrated by the fragment in Box 3.5, in which students discussed their prediction what would happen if a specific product becomes cheaper:

Box 3.5: Transcript from the Experiment Participation Condition

| Student-C: | \textit{It becomes less expensive.} |
| Student-D: | \textit{So, when I have to choose an option... it \textit{f=} the price\textit{d} decreases.} |
| Student-C: | \textit{As a result, more will be sold... because it is cheaper... As an explanation? Yeah... Ehm... because it is cheaper........ Ready!} |

Students in the experiment participation condition seemed to finish their reasoning by repeating a cause and its effect, rather than by providing an actual explanation.
The subjective learning experiences by the students may illustrate the findings regarding knowledge and reasoning gains from another perspective. These self-reported experiences reflect the students’ perception of the underlying learning goals in the research conditions and can be found in Table 3.7. The first sentence-starter depicted in Table 3.7 regards the usefulness that the students in each condition attributed to the teaching/learning activities in which they participated. It can be noticed that almost twice as many students in the data analysis condition (20%) reported the acquisition of thinking and reasoning skills, which was the main overarching learning goal of each of these research conditions, than students in the experiment participation condition (11.8%). Moreover, although only one student (2.5%) in the data analysis condition reports the lessons the be useful for nothing, almost one-fifth of students in the experiment participation condition reports the lessons to be unvaluable. An equal share of about fifteen percent of students in both of the research conditions report the usefulness of what was learned during the lessons for application later on in real life.

The second sentence-starter reported in Table 3.7 regards what students remembered best from the teaching/learning activities in which they participated. Students who participated in economic classroom experiments reported having learned how to negotiate prices (26.5%), and how to draw/interpret graphs and tables (13.2%). These learning experiences were hardly reported by students in the data analysis condition (0% and 2.9% respectively). As can be noticed, students in the latter condition mainly reported their acquisition of reasoning skills (21.1%), as well as their ability to set up predictions (15.8%). These two aspects were not mentioned by students in the experiment participation condition at all.
Table 3.7 Student Self-Reports

<table>
<thead>
<tr>
<th>The students report the teaching/learning activities they attended</th>
<th>Experiment Participation Condition N=36</th>
<th>Video Observation Condition N=27</th>
<th>Data-analysis condition N=45</th>
</tr>
</thead>
<tbody>
<tr>
<td>to be useful for...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>learning about the school subject of economics</td>
<td>7</td>
<td>N/A</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>(20.6)</td>
<td></td>
<td>(37.5)</td>
</tr>
<tr>
<td>their own future</td>
<td>1</td>
<td>N/A</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>(2.9)</td>
<td></td>
<td>(17.5)</td>
</tr>
<tr>
<td>the application of it in real life</td>
<td>6</td>
<td>N/A</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(17.6)</td>
<td></td>
<td>(15.0)</td>
</tr>
<tr>
<td>learning how to think/reason</td>
<td>4</td>
<td>N/A</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(11.8)</td>
<td></td>
<td>(20.0)</td>
</tr>
<tr>
<td>nothing</td>
<td>7</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(20.6)</td>
<td></td>
<td>(2.5)</td>
</tr>
<tr>
<td>other</td>
<td>9</td>
<td>N/A</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>(26.5)</td>
<td></td>
<td>(7.5)</td>
</tr>
<tr>
<td>no response / missing</td>
<td>2</td>
<td>27</td>
<td>5</td>
</tr>
<tr>
<td>to show them they were capable of...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>drawing and interpreting graphs and tables</td>
<td>1</td>
<td>N/A</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>(2.9)</td>
<td></td>
<td>(13.2)</td>
</tr>
<tr>
<td>predicting what would happen in a certain situation</td>
<td>0</td>
<td>N/A</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>(0.0)</td>
<td></td>
<td>(21.1)</td>
</tr>
<tr>
<td>setting up reasoning</td>
<td>0</td>
<td>N/A</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>(0.0)</td>
<td></td>
<td>(15.8)</td>
</tr>
<tr>
<td>negotiating prices</td>
<td>9</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>(26.5)</td>
<td></td>
<td>(0.0)</td>
</tr>
<tr>
<td>nothing</td>
<td>1</td>
<td>N/A</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(2.9)</td>
<td></td>
<td>(2.6)</td>
</tr>
<tr>
<td>other</td>
<td>23</td>
<td>N/A</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>(67.7)</td>
<td></td>
<td>(47.3)</td>
</tr>
<tr>
<td>no response / missing</td>
<td>2</td>
<td>27</td>
<td>7</td>
</tr>
</tbody>
</table>

Notes. Data are reported: Absolute number (percentage of within-group total excluding non response/missing) of similar student answers within each condition. N/A = no data available.
3.5 DISCUSSION AND CONCLUSION

This study explored whether and how economic classroom experiments can support secondary school students’ knowledge of economic concept and their ability to set up economic reasoning. Students in the three research conditions actively engaged in inquiry learning processes in which they formulated and tested hypotheses by deriving key variables, determining how these variables are related, and providing explanations. The outcomes suggest that participating in economic classroom experiments is less beneficial for the knowledge retention of economic concepts than are the observation of economic classroom experiments and the analysis of experimental data. Although this finding seems to contradict the findings presented in Chapter 2, this conclusion should be drawn with vigilance as knowledge retention was not measured in that particular study and as the teaching/learning environments in the two studies differed: The present study aimed at enhancing economic reasoning through the use of economic classroom experiments. The teaching/learning activities in the three research conditions directed the students towards the generation and testing of hypothesis instead of the “plain” understanding of economic concepts, as has been the case in the study described in Chapter 2. Another conclusion of the research presented in this study is that experiment participation turns out to be less beneficial for the reasoning-ability of students than video observation and data analysis. This finding is in line with the suggestion by Cartwright and Stepanova (2012) that playing economic classroom experiments might be less essential and that less-demanding teaching/learning activities, such as analyzing data, might suffice.

The recordings of the student dialogues and the student self-reports further clarify these findings. First, the analysis of student dialogues indicates economic reasoning to be more supported in the data analysis condition than in the two other conditions. Students in the data analysis condition more frequently mention causes, effects, and explanations during class than students in the other conditions. This might have allowed students in the data analysis condition to further strengthen their reasoning. Moreover, students in the data analysis condition and
video observation condition more often use economic principles in formulating their arguments than students in the experiment participation condition. As principles are considered important for explaining relationships between causes and effects (e.g., Eiriksdottir & Catrambone, 2011; Jonassen & Ionas, 2008), it could be argued that the line of reasoning by the students in the experiment participation condition, who hardly used these principles actively during argumentation, might have been hampered and their construction of accurate mental models could have been suboptimal (cf. Barnett & Ceci, 2002; Duff & Barnard, 1990). This, in turn, may have resulted in less favorable scores for the students who participated in economic classroom experiments.

Second, the learner reports show that the main aim of the current research, namely learning how to set up economic reasoning, is much more frequently self-reported by students in the data analysis condition than by students in the experiment participation condition. In turn, students in the experiment participation condition more frequently report having learned skills such as negotiating prices. Hence, from a student’s perspective, the experiment participation condition seems to have triggered “hands-on” learning experiences and might have turned economic reasoning into a less important learning objective to them.

Previous research has pointed out positive associations between student performance and learning environments that reduce the cognitive short term memory load of students (Kirschner et al., 2006). In the current study, students enrolled in the data analysis condition formulated a hypothesis and explained an economic phenomenon based on their analysis of data from a given case. Students in the video observation condition also observed and recorded the observational data. Moreover, students in the experiment participation condition also generated data by participating in the experiment. Hence, although students in all conditions were provided with scaffolds and tools to reduce memory demand, the effects on knowledge gains and reasoning ability seemed most profitable for students enrolled in the least demanding teaching/learning activities. Future research might therefore investigate the use of other
supportive tools that may reduce further the memory demand while participating in economic classroom experiments.

It can also be argued that learning to reason is a process that requires more time to become automated (cf. Marzano & Miedema, 2011). Perhaps a longer treatment period could reduce memory demand even further. To investigate this, studies with a more longitudinal character could be designed. Future research might also extend economic reasoning to more complex problems for students to deal with, such as the probability and duration of the relationships between variables, or to problems that include cyclical causality (cf. Jonassen & Ionas, 2008).

The present study shows that both analyzing data and observing experiments seem more advantageous for gaining economic knowledge and economic reasoning than participating in economic classroom experiments. However, the question arises whether analyzing data does prepare students for situations they will face later on in life. In real-life settings, people are less likely to be asked to analyze datasets. Instead, people have to make sound economic decisions on a regular basis, often in direct interaction with others. Of the three conditions, the experiment participation condition seems to resemble such a real life situation best. Hence, how participation in economic classroom experiments relates to the transfer of classroom learning to real-life situations and economic decision making needs further investigation. This will be elaborated on in Chapters 4, 5, and 6.
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CHAPTER $3^{1/2}$
CHAPTER 3½

YOU WON’T SEE IT TILL YOU GET IT

Imagine wandering along the galleries of the “Gemeentemuseum” in The Hague, looking at all the beautiful modern paintings, sculptures, and objects. A painting in one of the exhibition rooms catches your attention, so you stop to take a closer look:

![Image 1](image1)

Not everyone will be able to interpret the meaning of this modern artwork as intended by the artist straightaway. When you look around, you see two more paintings by the same artist:

![Image 2](image2) ![Image 3](image3)
The red tree (Image 3) was painted by Piet Mondriaan in the period 1908-1910, The grey tree (Image 2) in 1911, and Flowering apple tree (Image 1) in 1912. Even though you may not have recognized the tree in the first image straightaway, the addition of two new sources of information may have assisted you in decoding and identifying the tree in the first work of art.

Legendary Dutch soccer player Johan Cruyff once said: “You won’t see it till you get it”\(^\text{16}\). The experience you have just gone through might raise awareness that the addition of two analogies can be of assistance in detecting overarching similarities. These might enable you to identify the meaning of a modern artwork, as intended by the artist, more or less all by yourself.

Although this thought experiment is framed within the context of modern art works in a Dutch museum, students in secondary education face similar situations during economics class when asked to transfer an economic concept across contexts. Students find this difficult. A major challenge to teachers is creating possibilities for their students to guide them \textit{how to get it}, as this requires suitable sources or tools that can support the underlying decoding and interpretation processes. Following this line of thought, the next chapters describe how students in secondary education can be supported in transferring economic concepts across contexts.
CHAPTER 4
CHAPTER 4

SUPPORTING TRANSFER OF ECONOMIC CONCEPTS THROUGH ANALOGICAL REASONING IN SECONDARY EDUCATION

ABSTRACT
Transfer can be depicted as someone’s ability to recognize certain knowledge or skills in new situations. The present study explores the extent to which economic classroom experiments promote the ability of secondary school students to identify, formulate, and illustrate the structural similarity between situations that differ in surface characteristics. This process of analogical reasoning is considered vital for transfer. Students in the experiment condition (n = 43) first participate in an economic experiment. Hereafter, they read two stories. Students in the stories condition (n = 24) read three stories. Next, all students are asked to compare and contrast these three situations by means of explicit questions. These questions regard the ability of students (1) to identify and generalize key elements from specific situations, (2) to formulate an overarching economic concept verbally, and (3) to illustrate this concept graphically. Each step of this process is documented by collecting student responses. Contrary to the research hypothesis, students in the stories condition seem to outperform students in the experiment condition on each of the three steps. Possible reasons for this are elaborated.

KEY WORDS
Analogical reasoning; economic classroom experiment; secondary education; transfer.

JEL-CLASSIFICATION
A21, D00.

SUBMITTED
4.1 INTRODUCTION

In a 1999-poll in the United States, “only one in three [respondents] knew that those who borrow money at a fixed interest rate are most likely to benefit from inflation” (Salemi, 2005, p. 46). Even though there is a possibility that people did not acquire this knowledge at all during formal education, an alternative explanation is that a substantial share of people lack the ability to apply the concepts they once learned in economics class to situations they face later on in everyday life. The ability to recognize and use certain knowledge or skills in a new situation is often referred to as transfer (e.g., Alexander & Murphy, 1999; Simons, 1999; Stark, Mandl, Gruber, & Renkl, 1999). Some scholars show optimism with regard to ways in which transfer could be supported in educational settings: “Although transfer may not typically occur in classroom settings on its own, there is every reason to believe that it can be encouraged. If only we teach it, we are most likely to get it” (Salomon & Perkins, 1989, p. 137). Nevertheless, others, such as Detterman (1993) doubt the learn-ability of transfer.

Recently, interest in transfer in economics education has increased. The ability to review everyday life phenomena from an economic perspective, the skill to recognize basic economic concepts in an array of circumstances, and the development of understanding of economic concepts that concern a variety of daily matters is stressed in curriculum plans worldwide, such as in the United States’ Voluntary Content Standards in Economics (Siegfried et al., 2010) and the Subject Content for Economics in the United Kingdom (Department for Education [DfE], 2014). Also the national examination criteria for economics in secondary education in the Netherlands aim at bringing students to a better understanding of the society in which they live and in which economic mechanisms play a major role (Teulings et al., 2005). Moreover, the latter standards aim specifically teaching students to recognize economic concepts in a wide variety of contexts. Together, these aims imply that economics teachers in secondary education have to guide their students in developing the ability to transfer economic concepts found in textbooks and exercises across a variety of real world contexts.
Research on how to foster transfer in economics education, however, seems rather scarce. A literature search in databases such as Web of Science and ERIC reveals only three relevant publications, all by the same principal investigator (Kneppers, 2007; Kneppers, Elshout-Mohr, & Van Boxtel, 2007; Kneppers, Van Boxtel, & Van Hout-Wolters, 2009). Aiming at reaching transfer within the secondary school subject of economics, Kneppers compared a context route to transfer, in which students studied economic concepts while applying these in a context, with a concept route to transfer, in which students studied economic concepts before they were asked to apply these in a context. All students were asked to create concept maps in pairs during these lessons. A concept map can be regarded a visual diagram representing relationships between variables and/or examples. Students in the concept condition drew their initial maps based on a list of economic concepts, whereas the students in the context condition drew these maps based on a case that represented a recent economic situation. Then, students in both conditions were asked to refine their concept maps based on extra information that was handed out to them. The first study reported by Kneppers (2007) and Kneppers et al. (2007) showed that students who were enrolled in the context condition constructed more links between well-known contexts and concepts than students in the concept condition. Another finding was that no significant differences between the two research conditions were found on the far transfer test, in which students were presented with problems that consisted of concepts and contexts that were new to them. A second, larger-scaled study indicated, however, that students enrolled in the context condition seemed to construct as many links between contexts and concepts as students in the concept condition, and that both groups of students significantly improved in conceptual knowledge. Similar to the pilot study, though, students in the concept condition did not reach far transfer more frequently than students in the context condition (Kneppers, 2007; Kneppers et al., 2009).

Reflecting on these findings, Kneppers (2007) questions the extent to which far transfer could be achieved in secondary education. Her suggestions regard, amongst others, not to
neglect the importance of fostering and documenting the extent to which students are prepared for future learning instead of measuring only student output through a formal transfertest. Following this line of thought, investigating transfer within secondary school economics may focus on the ability of students to compare different situations that share an overarching similar structure with each other. The latter can be considered an important skill preceding the direct application of the knowledge under transfer (cf. Bransford & Schwarz, 1999). Studying the processes in which students compare and contrast situations and by means of which they formulate abstractions implies a focus at the process of analogical reasoning. Findings from previous research in this area are discussed in section 4.2. In section 4.3, the research question and hypothesis are stated. Section 4.4 describes the research method. In section 4.5 the results are presented. Finally, these findings are discussed and elaborated on in section 4.6.

4.2 SUPPORTING TRANSFER OF ECONOMIC CONCEPTS

Thorndike and Woodworth (1901) already suggested that transfer depends on the similarity, or “identical elements”, between a learning task and a transfer task. Identifying similarities between a known source and a new, less comprehended target can be labeled analogical reasoning (Holyoak & Koh, 1987). Students who apply analogical reasoning discover correspondences between situations via a mapping process (Bernardo, 2001; Day & Goldstone, 2012; Richland, Stigler, & Holyoak, 2012). The intensive comparing and contrasting of characteristics of specific situations allows these students to come up with a solution for the transfer problem they have to solve.

Following this line of thought, transfer can be considered a process of comparing situations and discovering and applying analogies. To investigate the process of analogical reasoning in more detail, Gick and Holyoak (1983) performed a series of analogical reasoning experiments in which they provided their participants with a written story that described a problem and its solution. After reading this source case, the participants received another story
which included a problem that could be solved by analogy to the first. One of these stories was about a general who occupied a fortress and had put land mines on all roads leading to the fortress. These mines would detonate if large groups of soldiers would step on them. The solution to the problem was that the attacking army would split up into small groups of soldiers to attack the fortress from several roads at the same time, to assure that all soldiers would arrive together at the fortress and none of the land mines would explode. After reading this story, participants received a text regarding a radiation problem in which a doctor faced the problem of treating the tumor of his patient with a energy beam that was so powerful that it could destroy not only the tumor but the surrounding and healthy tissue as well. The radiation problem could be solved by analogy to the story of the general who had to be dismissed from the occupied fortress. Although the surface characteristics of these stories differed to a large degree (a general had to be compared to a doctor), these stories shared common underlying characteristics (e.g., the idea that a successful solution could be reached by applying multifaceted interventions).

Studies following this research tradition have focused on providing participants with written sources and whereafter they were presented with a target case they had to solve (Day & Goldstone, 2012). A general finding is that transfer does not occur spontaneously and that students should be supported in the analogical reasoning process (e.g., Catrambone & Holyoak, 1989; Gick & Holyoak, 1983). A number of mechanisms has been disclosed in subsequent studies that could guide students in transferring concepts across contexts. The first finding is that research participants who received two source cases from which inferences could be drawn with respect to the target case (or by offering them a hint) increased the number of participants that was able to solve the transfer case noticeably (Gick & Holyoak, 1983). Further research showed that the extensive comparison of two or more sources allowed students to solve the transfer problem even better (Catrambone & Holyoak, 1989; Richland et al., 2012).

It was also observed that students who were asked to compare two written stories that shared a common underlying structure mainly reacted to unimportant surface characteristics
that could be clearly observed (Chi & Van Lehn, 2012; Ntim, 2013). Students found it hard to
detect and formulate the deep similar structure underlying the stories. This ability, though, is
considered essential for reaching transfer as it helps learners to formulate abstractions that are
applicable in multiple situations (e.g., Day & Goldstone, 2012; Engle, Lam, Meyer, & Nix,
2012; Gentner & Medina, 1998; Gentner, Loewenstein, & Thompson, 2003; Ntim, 2013). As
an example, the concrete term “a one Euro coin” refers to a specific object only, whereas the
more abstract term “a means of exchange” can be applied in a wide array of situations. A
congrete term can directly be perceived by one’s senses, whereas an abstract term transcends
this literal perceptibility and is described in a more general and formal way (e.g., Van Boxtel,
1995). By abstracting from a specific context, students acquire a representation of a more
general, overarching concept that is applicable to a larger variety of contexts than was the
terminology that was used in the specific situation with which the students were presented
(Radder, 2007; Salomon & Perkins, 1989). This implies that once such an abstraction regarding
the deep common structure of cases has been formulated consciously by the students, students
can recognize and use it in new contexts more easily (Kneppers, 2007; Salomon & Perkins,
1989). This is why several tools have been designed that might help students, being novice
learners, to discern the overarching structural similarities of sources and to formulate the
underlying similarity of cases in abstract terms.

An example of such guidance could be the use of explicit questions which can draw a
student’s attention to the underlying similar deep structure (Catrambone & Holyoak, 1989). The
development of more abstract schemas (Gentner et al., 2003) and the construction of more
complete mental models (Barnett & Ceci, 2002; Duff & Barnard, 1990) could be fostered by
asking students to replace specific terms from each of the target cases they compare with each
other by a more general, overarching term (e.g., Catrambone & Holyoak, 1989). This “explicit
conscious formulation of abstraction in one situation that allows making a connection to
another” (Salomon & Perkins, 1989, p. 118) has been identified as the high road to transfer.
Providing students with explicit guidance in the process of formulating abstractions may increase the likelihood of transfer.

Instead of providing students with stories only, Gick (1985) used sources in multiple forms to support analogical reasoning processes. One group of students was provided with a source story and an abstract diagram representing the story, whereas another group of students received only diagrams as a source. Gick (1985) identified that the relative number of students that was able to solve the transfer task was equal for both groups, and comparable to findings from previous research in which students read written stories only (Gick & Holyoak, 1983). Furthermore, providing students with explicit cues and hints increased their ability to solve the transfer tasks noticeably (Gick, 1985). However, as students had to study existing stories or diagrams only, they were not given any opportunity to actively discover the mechanisms present in the source situations, nor were they challenged to create abstractions actively by themselves (cf. Salomon & Perkins, 1989). As discussed in Chapter 1, the latter is considered important also from the angle of social-constructivism: Learning by inquiry and by gaining personal experiences may help students in their construction of knowledge. This is why the present study aims at developing and testing a teaching/learning approach that supports analogical reasoning by using economic classroom experiments. Following the definition presented in Chapter 1, these experiments can be defined as controlled interactive teaching/learning exercises that target a student’s understanding of economics in a bottom-up way. Instead of being passive recipients of information, students engaged in an economic classroom experiment become active participants who interact which each other. Previous research regarding the educational value of economic classroom experiments has been focused on measuring student understanding of economic concepts and on economic reasoning, however, none of these studies investigated how economic classroom experiments can contribute to the transfer of economic concepts through analogical reasoning yet (see Table 1.1).
4.3 RESEARCH QUESTION AND HYPOTHESIS

The present study examines to which extent students are able to identify and formulate the structural similarities that underlie three different situations. Following mechanisms that may foster transfer according to the literature, this ability is divided in three steps: (1) identifying and generalizing key elements from specific situations, (2) formulating an overarching economic concept verbally, and (3) illustrating the general economic concept graphically. The main research question is: To which extent can economic classroom experiments promote the ability of secondary school students to identify, formulate, and illustrate the structural similarity between situations that differ with respect to their surface characteristics? It is hypothesized that the interactive participation in an economic classroom experiment, followed by reading and comparing two stories, is better for identifying, formulating, and illustrating an overarching economic concept in a variety of situations than is the reading and comparing of three stories (Research Hypothesis).

4.4 METHOD

4.4.1 PARTICIPANTS

Schools for lower general secondary education\textsuperscript{18}, recruited via the professional network of the investigators, were randomly assigned to the experiment condition (3 classes, 77 students) and the stories condition (1 class, 27 students). Before the research started, the students had acquired quite similar knowledge of basic economic principles as they were enrolled in their first year of formal economics education. The study took place in June 2014. Only one condition per school was applied. Demographic data, such as sex, age, and grade point averages (GPAs) for the school subjects of economics, mathematics, and Dutch language, were collected using official school records (cf. Maxwell & Lopus, 1994). Due to a lack of available student-specific data beforehand, post-hoc matching was applied to further balance the composition of student characteristics (age, gender, GPAs, and ASM-scores) among conditions. This resulted in the
inclusion of 67 students, on average aged 15.5 years (SD=0.6), of whom 21 (31.3%) were female. For measuring baseline student motivation for the school subject of economics, a slightly adapted version of the Attitude Scale towards Mathematics (ASM) questionnaire (Martinot, Kuhlemeier, & Feenstra, 1988) was included. In this version of the ASM the school subject “mathematics” was replaced with “economics”. Students scored their level of agreement with testimonials such as: “I enjoy economics class” on a 4-point Likert scale which ranged from “totally disagree” to “totally agree”. Exploratory factor analysis indicated that the present version of the ASM measured the four underlying constructs of pleasure, no fear/difficulty, interest/devotion, and profit/relevance. These factors showed an average to good internal consistency (αs ranging from .59 to .91). Table 4.1 shows summary statistics.
Cross tabulations and ANOVAs showed that randomization and post-hoc matching ruled out most of the between-group differences, with the exception of the student scores on the ASM-dimension “No fear / difficulty”, which was taken into account by using it as a covariate in further analyses.

Table 4.1  Demographic Data and Learning Preconditions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total All Conditions N=67</th>
<th>Experiment Condition N=43</th>
<th>Stories Condition N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>15.5 (0.6)</td>
<td>15.3 (0.6)</td>
<td>15.6 (0.6)</td>
</tr>
<tr>
<td>Female</td>
<td>21 (31.3)</td>
<td>13 (30.2)</td>
<td>8 (33.3)</td>
</tr>
<tr>
<td>GPA Economics</td>
<td>6.4 (0.8)</td>
<td>6.3 (0.7)</td>
<td>6.6 (0.8)</td>
</tr>
<tr>
<td>GPA Mathematics</td>
<td>5.6 (0.9)</td>
<td>5.7 (0.8)</td>
<td>5.6 (1.1)</td>
</tr>
<tr>
<td>GPA Dutch language</td>
<td>6.3 (0.5)</td>
<td>6.4 (0.4)</td>
<td>6.2 (0.7)</td>
</tr>
<tr>
<td>ASM Pleasure</td>
<td>24.0 (5.7)</td>
<td>23.5 (6.5)</td>
<td>24.9 (3.7)</td>
</tr>
<tr>
<td>ASM No fear / difficulty</td>
<td>26.5 (5.3)</td>
<td>25.3 (6.2)</td>
<td>28.6 (1.9)</td>
</tr>
<tr>
<td>ASM Interest / devotion</td>
<td>18.8 (3.5)</td>
<td>19.0 (3.8)</td>
<td>18.5 (2.8)</td>
</tr>
<tr>
<td>ASM Profit / relevance</td>
<td>24.5 (4.2)</td>
<td>24.5 (4.8)</td>
<td>24.6 (2.8)</td>
</tr>
</tbody>
</table>

Notes. All data are reported [mean (SD)], except for Female: [Number of female students (%)]; Age: The age of the respondent; Female: Number of female students; GPA: Grade point average on a scale ranging from 1 (lowest possible score) to 10 (highest possible score); ASM: The slightly modified version of the Attitude Scale towards Mathematics (Martinot et al., 1988).
4.4.2 MEASURES AND COVARIATES

To measure transfer, participants were asked to answer a set of six questions that were inspired by previous work of Catrambone and Holyoak (1989). These questions were designed to break down the process of transfer into three smaller steps during which students could compare and contrast the different situations with which they were presented, namely identifying and generalizing key elements of the situations, verbally formulating an economic concept, and graphically illustrating the economic concept (see Box 4.1).

<table>
<thead>
<tr>
<th>Steps</th>
<th>Accompanying Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Identifying and generalizing key elements</td>
<td>(1) Replace the specific terms “apple buyers” from situation 1, “cheetahs” from situation 2, and “parents” from situation 3 by a more general term that could be used in all three situations.</td>
</tr>
<tr>
<td>(2) Verbally formulating an economic concept</td>
<td>(2) Replace the specific terms “apple sellers” from situation 1, “deer” from situation 2, and “child day care managers” from situation 3 by a more general term that could be used in all three situations.</td>
</tr>
<tr>
<td>(3) Graphically illustrating the economic concept</td>
<td>(3) Describe the outcomes for each of the three situations.</td>
</tr>
<tr>
<td>(4) Describe how these outcomes resemble each other.</td>
<td>(5) Formulate a general economic concept that describes the similarity between the three situations in a single sentence.</td>
</tr>
<tr>
<td>(5) Formulate a general economic concept that describes the similarity between the three situations in a single sentence.</td>
<td>(6) Draw a sketch, as if you were an economist, that graphically illustrates this overarching concept.</td>
</tr>
</tbody>
</table>

Student answers were handed in and collected after completion. Individual student responses to the questions were copied on separate cards and mixed. Being blind for conditions, two independent raters grouped these cards and labeled them. As an example, the student answers regarding questions 1 and 2 were classified into either concrete or abstract terms as a conscious formulation of abstractions is considered important for transfer (e.g., Kneppers, 2007; Salomon & Perkins, 1989). Concrete terms are more or less literally detectable (Van Boxtel, 1995), for example, when strolling down a market, one could literally observe buyers or sellers. An economic concept such as demand, on the other hand, cannot be straightforwardly observed in...
a literal sense (cf. Van Boxtel, 1995). This term was therefore tagged *abstract*. Disagreement between raters was resolved by consensus. Finally, frequencies were calculated for each label. Over all, the intra-class correlation (two way mixed model, absolute agreement, single measures) between the two raters pointed out to be substantial: ICC=.830 (*p*=.015), 95% CI (0.144, 0.975).

### 4.4.3 RESEARCH DESIGN

To address the research question and to test the research hypothesis, two research conditions were created. In the experiment condition, all students participated in an economic classroom experiment based on the apple market experiment by Bergstrom and Miller (1997, 1999) first. This experiment illustrated the equilibrium concept by addressing demand and supply behavior in a competitive market. Hereafter, all students individually read two stories. These stories illustrated the same equilibrium concept in two other, distinct contexts, namely a game reserve and child day care facilities. Although the three contexts differed with regard to their surface characteristics, structural similarity was assured via the overarching economic concept of equilibrium.

Next, students received a hand-out in which they were asked to answer questions regarding the three situations. As literature suggests that peer dialogues could enhance the quality of student reasoning (e.g., Mercer, Dawes, Wegerif, & Sams, 2004), students were given the opportunity to share and discuss their answers to these questions in pairs. The teacher paired neighboring students. Ground rules to regulate this peer communication, such as: “We always provide arguments for the statements we make” (e.g., Mercer, 1995; Wegerif, 2001) were handed out and explained to the students beforehand. Students were allowed to replace their initial answers based on their dialogues with their fellow students. A similar sequence of activities holds for the stories condition, except for the first activity; instead of being actively...
engaged in the classroom experiment, students in the stories condition read a story illustrating the experiment (Box 4.2, Story 1).

### Box 4.2 Three Stories on Equilibrium

| Story 1: The Apple Market | A group of twenty-four students was divided in two sub groups. Twelve students were assigned the role of sellers. The other twelve students were assigned the role of buyers. All buyers desperately wanted to buy apples. All sellers possessed an equal number and quality of apples. Hence, for buyers it made no difference from whom they would buy apples. All sellers needed a minimal bid for their apples. They could not sell them for a price that was lower than their cost of production. Eight sellers had production costs of 10 Euros each, four sellers had production costs of 30 Euros each. All buyers possessed information with regard to the maximum budget they could spend on apples. They were not allowed to buy apples for a price exceeding their budget. Eight buyers had an individual budget of 20 Euros, four buyers had an individual budget of 40 Euros. Buyers and sellers met each other during several rounds. In each round, sellers were on the lookout for buyers and vice versa. Once they found each other, they tried to close a deal. As soon as they reached agreement, the price was called out aloud to inform all players in the market. Not everyone reached agreement in every round. Prices converged over the course of several rounds. On average, sellers agreed to sell the apples for 20 Euros, and buyers agreed to buy the apples for 20 Euros. |
| Story 2: Game Reserve | Only deer (prey) and cheetahs (predator) live in a game reserve full of grass, far away from here. The prey only eat grass. The predator only eat prey. When deer are relatively abundant, it is relatively easy for cheetahs to find them and catch them. In such a situation, baby cheetahs – who are fed with freshly caught deer by their parents – will have good opportunities to survive, for deer are abundant. Baby cheetahs will become big and strong soon. However, as more and more deer are caught by cheetahs, the number of prey in the game reserve will start to decline. It becomes more difficult for predators to find and catch deer. In such a situation, baby cheetahs will have a smaller chance to survive, and their number will decrease. When cheetahs are relatively scarce, fewer deer will be caught and eaten. In such a situation, the number of deer will increase. |
| Story 3: Child Day Care | In a small community, far away from here, all 120 families consist of two parents and one child. Parents who both work, need day care facilities. To pay for this service, they make use of their own financial resources. Ten day care facilities are in charge of providing day care in this country. They charge families a fixed price a week for using their facilities. On average, they charge 400 Euros per child per week. In total, 100 children can be placed in these facilities. A recent survey among parents who both like to work, shows that 80 pairs of parents have a weekly budget of 200 Euros for day care. Forty pairs of parents have a weekly budget of 400 Euros for day care. The government in this country is not involved in day care. The question arises how it can be guaranteed that all pairs of parents who like to go to work can place their child in day care facilities. |

**Notes:** The first story was inspired by Bergstrom and Miller (1997, 1999). All stories were written for educational purposes in secondary education and they are therefore not intended to reflect the precise research procedures or results of the aforementioned publications. Students in the Experiment condition participated in an experiment similar to the situation described by story 1. Thereafter, they read stories 2 and 3. Students in the Stories condition read all 3 stories.
4.4.4  PROCEDURE

All participating teachers received a personal training from the main researcher and an assistant prior to the start of the study as all students were taught and tested by their regular teachers. This training involved a thorough discussion and elaboration of all teaching/learning materials and measurement instruments. These were handed out to the teachers to make sure that they were well aware how to perform the teaching/learning activities, which documents they had to hand out at which moment in time, as well as how they could collect and hand-in the data afterwards. Meetings lasted about 50 minutes each. In the first meeting, the data regarding learning preconditions were collected and students filled out the ASM-questionnaire. The intervention and the accompanying transfer measurement took place in a second meeting.

4.5  RESULTS

4.5.1  IDENTIFYING AND GENERALIZING KEY ELEMENTS

Students in all conditions were capable of replacing specific words from the three situations with an overarching term that illustrated the same concept. The terms students used when describing the similarities between apple buyers (situation 1), cheetahs (situation 2), and parents (situation 3) are depicted in Table 4.2. As illustrated in section 4.4.2, all student answers were classified into either concrete or abstract terms. The terms buyer and consumer were tagged concrete, and demand was labeled abstract. Following this distinction, it can be noticed from Table 4.2 that 90% of the students in the experiment condition formulated the similarity between the three concepts in more concrete terms, whereas a smaller share of 75% of the students in the stories condition did so. None of the students in the experiment condition seemed to have employed the abstract term demand, whereas 17.4% of students in the stories condition used it to formulate structural similarities.
Table 4.2  
Student Formulations of Terms Related to Demand Behavior

<table>
<thead>
<tr>
<th>Student Formulation</th>
<th>Classification</th>
<th>Total All Conditions</th>
<th>Experiment Condition</th>
<th>Stories Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>N=67</td>
<td>N=43</td>
<td>N=24</td>
</tr>
<tr>
<td>Buyer</td>
<td>Concrete</td>
<td>1</td>
<td>1 (2.5)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.6)</td>
<td>(87.5)</td>
<td>(75.0)</td>
</tr>
<tr>
<td>Consumer</td>
<td>Concrete</td>
<td>53 (84.1)</td>
<td>35 (87.5)</td>
<td>18 (75.0)</td>
</tr>
<tr>
<td>Demand</td>
<td>Abstract</td>
<td>4 (6.3)</td>
<td>0 (0.0)</td>
<td>4 (17.4)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>5 (7.9)</td>
<td>4 (10.0)</td>
<td>1 (4.3)</td>
</tr>
<tr>
<td>No answer at all</td>
<td></td>
<td>4</td>
<td>3</td>
<td>1</td>
</tr>
</tbody>
</table>

*Notes.* All data are reported [total number (% of within group total)]. Students who did not provide an answer were excluded from the calculation of within group percentages.

As grade point averages for economics and student scores on the ASM-dimension No fear/difficulty were correlated with the extend to which students formulated abstract terms, an ANCOVA was performed. This analysis revealed a main effect of condition after adjusting for these confounders: $F(1, 54)=5.93, p=.018$, $\eta_p^2=.10$ ($R^2=.24, \text{adj.} R^2=.20$). Simple contrast analysis showed that students enrolled in the stories condition made significantly more use of the abstract term *demand* for describing the similarity between the three situations than did students who were enrolled in the experiment condition (Stories vs. Experiment, *contrast estimate*=0.167, *SE*=0.07, *p*=.018).

Table 4.3 displays the terms that were used by the students to describe the resemblances between apple sellers (situation 1), deer (situation 2), and child day care managers (situation 3). Again, the student answers were classified into either concrete or abstract terms. The terms *seller* and *producer* were tagged *concrete*, and *supply* was labeled *abstract*. Following this
distinction, it can be noticed from Table 4.3 that almost 95% of the students in the stories condition and a much smaller share of 12.5% of the students in the experiment condition came up with an abstract overarching term. As grade point averages for economics and student scores on the ASM-dimension No fear/difficulty were correlated with the extend to which students formulated abstract terms, an ANCOVA was performed. This analysis revealed a main effect of condition after adjusting for these confounders: $F(1, 45)=82.84$, $p<.001$, $\eta_p^2=.66$ ($R^2=.71$, adj.$R^2=.69$). Simple contrast analysis showed that students enrolled in the stories condition made significantly more use of the abstract term *supply* for describing this specific similarity between the three situations than did students who were enrolled in the experiment condition (Stories.vs.Experiment, contrast estimate $= 0.835$, SE $= 0.09$, $p < .001$).

Table 4.3 Student Formulations of Terms Related to Supply Behavior

<table>
<thead>
<tr>
<th>Student Formulation</th>
<th>Classification</th>
<th>Total All conditions</th>
<th>Experiment Condition</th>
<th>Stories Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seller</td>
<td>Concrete</td>
<td>4 (7.0)</td>
<td>4 (10.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Producer</td>
<td>Concrete</td>
<td>22 (38.6)</td>
<td>22 (55.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Supply</td>
<td>Abstract</td>
<td>21 (36.8)</td>
<td>5 (12.5)</td>
<td>16 (94.1)</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>10 (17.6)</td>
<td>9 (22.5)</td>
<td>1 (5.9)</td>
</tr>
<tr>
<td>No answer at all</td>
<td></td>
<td>10</td>
<td>3</td>
<td>7</td>
</tr>
</tbody>
</table>

Notes. All data are reported [total number (% of within group total)]. Students who did not provide an answer were excluded from the calculation of within group percentages.
4.5.2  FORMULATING THE OVERARCHING ECONOMIC CONCEPT

Students were then asked to formulate an overarching economic concept that showed the overall similarity between the three situations. Table 4.4 shows summary statistics of the student answers regarding this question.

<table>
<thead>
<tr>
<th>Student formulation of the economic concept</th>
<th>Total all conditions N=67</th>
<th>Experiment-condition N=43</th>
<th>Stories-condition N=24</th>
</tr>
</thead>
<tbody>
<tr>
<td>An equilibrium in the market is reached</td>
<td>18 (46.2)</td>
<td>6 (30.0)</td>
<td>12 (63.2)</td>
</tr>
<tr>
<td>Supply and demand determine the price</td>
<td>9 (23.1)</td>
<td>4 (20.0)</td>
<td>5 (26.3)</td>
</tr>
<tr>
<td>Causality, e.g.,: If prices increase, revenues decrease</td>
<td>3 (7.7)</td>
<td>3 (15.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>People behave self-interested and/or profit-based</td>
<td>5 (12.8)</td>
<td>5 (25.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Other</td>
<td>4 (10.3)</td>
<td>2 (10.0)</td>
<td>2 (10.5)</td>
</tr>
<tr>
<td>No answer at all</td>
<td>28</td>
<td>23</td>
<td>5</td>
</tr>
</tbody>
</table>

Notes. All data are reported [total number (% of within group total)]. Students who did not provide an answer were excluded from the calculation of within group percentages.

Although students in all conditions seemed able to formulate an economic concept of which they thought that it would summarize the similarities between the three situations best, about
half of the students in the experiment condition and about one-fifth of the students in the stories condition failed to come up with their own formulation of an overarching economic concept.

From Table 4.4 it can be noticed that most students in the stories condition came up with overarching economic concepts in terms of *market equilibrium* (63.2%) and *the determination of prices via supply and demand* (26.3%), whereas students in the experiment condition also formulated their concepts in terms of *causality* (25%) and *outcomes resulting from profit and self-interest* (25%). Because the equilibrium concept was at the basis of the experiment and the stories, the student answers *An equilibrium in the market is reached* and *Supply and demand determine the price* were identified to represent the overarching structural similarity between the three situations best. An ANCOVA was performed as student scores on the ASM-dimensions Pleasure and No fear/difficulty were correlated with the extend to which students were able to come up with an accurate description of the overarching similar structure. This analysis revealed a main effect of condition after adjusting for these confounders: $F(1, 31)=6.14, p=.020$, $\eta^2_p=.18$ (R$^2=.44$, adj.R$^2=.38$). Simple contrast analysis showed that students enrolled in the stories condition were significantly better at verbally formulating the concept of equilibrium than were the students who were enrolled in the experiment condition (Stories.vs.Experiment, *contrast estimate*=0.308, $SE=0.12$, $p=.020$).

### 4.5.3 ILLUSTRATING THE OVERARCHING CONCEPT GRAPHICALLY

The last question in the student hand-ins concerned drawing the overarching economic concept that was identical for all three situations. Table 4.5 shows the categories of student drawings that were identified by the raters. Although students in all conditions seemed able to draw the economic concept of which they thought it would summarize the similarities between the three situations best, about half of the students in the experiment condition and about one-sixth of the students in the stories condition failed to come up with a drawing. A majority of the students in the stories condition drew the equilibrium concept by means of a supply-and-demand-graph
(60%), or indicated this concept by means of a scale/balance (25%). In the experiment condition, 41.2% of the students illustrated the dynamics of supply and demand over time by means of a cycle. As the concept of equilibrium was central to the design of the three situations, the raters considered the student drawings Supply, demand, and equilibrium and Scale/balance to resemble this overarching concept best.

Table 4.5 Student Drawings of the Overarching Economic Concept

<table>
<thead>
<tr>
<th>Drawings of Economic Concepts</th>
<th>Total All conditions</th>
<th>Experiment Condition</th>
<th>Stories Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=67</td>
<td>N=43</td>
<td>N=24</td>
</tr>
<tr>
<td>Supply, demand, and equilibrium</td>
<td>15 (40.5)</td>
<td>3 (17.6)</td>
<td>12 (60.0)</td>
</tr>
<tr>
<td>Scale/balance</td>
<td>8 (21.6)</td>
<td>3 (17.6)</td>
<td>5 (25.0)</td>
</tr>
<tr>
<td>Cycle</td>
<td>9 (24.4)</td>
<td>7 (41.2)</td>
<td>2 (10.0)</td>
</tr>
<tr>
<td>Causal model</td>
<td>2 (5.4)</td>
<td>2 (11.8)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Humans, animals, and/or money</td>
<td>3 (8.1)</td>
<td>2 (11.8)</td>
<td>1 (5.0)</td>
</tr>
<tr>
<td>No drawing at all</td>
<td>30</td>
<td>26</td>
<td>4</td>
</tr>
</tbody>
</table>

Notes. All data are reported [total number (% of within group total)]. Students who did not provide an answer were excluded from the calculation of within group percentages.
An ANCOVA was performed as student scores on the ASM-dimensions Pleasure and No fear/difficulty were correlated with the extent to which students were able to draw the overarching similar structure. This analysis revealed a main effect of condition after adjusting for confounders: $F(1, 34)=7.80, p=.009, \eta^2_p=.20$ ($R^2=.34$, adj.$R^2=.27$). Simple contrast analysis showed that students enrolled in the stories condition were significantly better at drawing the equilibrium concept than were the students who had been enrolled in the experiment condition (Stories-vs.Experiment, contrast estimate=0.430, $SE=0.15$, $p=.009$).

### 4.6 DISCUSSION AND CONCLUSION

Transfer of economic concepts does not seem self evident in everyday life. This study explored how transfer could be supported by using economic classroom experiments and stories to promote analogical reasoning. The latter process is considered important for transferring knowledge across contexts. Students were tested on their ability to compare three different situations and the extent to which they identified and formulated structural similarities between these. This ability was divided in three steps: (1) identifying and generalizing key elements from specific situations, (2) formulating an overarching economic concept verbally, and (3) illustrating the general concept graphically. Students enrolled in the experiment condition ($n=43$) first participated in an economic classroom experiment and thereafter read two stories. All other students were enrolled in the stories condition ($n=24$). These students did not participate in an economic classroom experiment, but read three stories instead. It was hypothesized that participating in an economic classroom experiment would be more beneficial for transfer than would be reading stories. Students in both conditions were guided in comparing and contrasting the three situations with which they were provided by means of explicit questions. Contrary to the initial expectations, results showed that students who were enrolled in the stories condition were significantly better at replacing specific terms by more abstract ones, at verbally
formulating the overarching equilibrium concept, and at graphically illustrating this concept than were the students in the experiment condition.

These findings may be explained by the overt teaching/learning activities that were present in each research condition. Maybe, the (inter)active nature of experiment participation in itself triggered more concrete observations and experiences by the students. In previous research, experiences of students enrolled in economic classroom experiments have been characterized as “hands-on”, as opposed to the more theoretical learning gains that were self-reported by students in control conditions (e.g., Chapter 2). The concrete experiences gained by students in the experiment condition during their participation in the experiment could have triggered them to write down more concrete terms when they were asked to describe the three situations. Following this line of thought, the absence of concrete experiences in the stories condition might have made students in this condition more prone to formulating terms at a higher level of abstraction. As the ability to formulate abstractions is considered vital for transfer (e.g., Salomon & Perkins, 1989), future research may design and study additional tools that further support the process of generating abstractions in the experiment condition especially.

Although one could argue that the use of economic classroom experiments seems less favorable at first sight than is the use of stories, this conclusion should be drawn with vigilance. First of all because this study did not investigate the direct application of students’ insights in transfer situations later on in life. In everyday life, analogical thinking does not aim at answering questions related to written stories, but at solving new problems by relating them to earlier situations one has encountered (cf. Holyoak, Junn, & Billman, 1984). Having participated in economic experiments in the classroom may as well contribute to recognition of all kinds of real-life aspects of economic behavior later on in life. Longitudinal research could study the ability of students to apply the analogical reasoning skills learned in class in real-life situations outside school, in everyday life.
Second, students had to formulate and draw an overarching economic concept all by themselves in the current study. The effects of handing out a list of concepts (cf. Box 3.1) or a set of graphical illustrations of the equilibrium concept (cf. Gick, 1985) to the students have not been investigated. Future research could study the effects of providing students with verbal and/or graphical concepts such as these and compare this to a research condition in which students design these all by themselves.

Third, as this study has been performed using a relatively small sample size, it should be regarded as only a small step towards a better understanding of how transfer could be supported by using economic classroom experiments and stories to promote analogical reasoning in economics class in secondary education. Further research is needed to confirm the present findings in a larger sample.

Finally, the experiment and stories used in this study were designed to illustrate the neoclassical economic concept of equilibrium. Scientific experiments by behavioral economists, however, depict an array of limitations of neoclassical economic theory. Hence, it could be interesting to study to which extent the transfer of an economic concept is influenced by the kind of concept that is under transfer. Following this idea, one could compare the process in which students transfer a neoclassical economic concept, such as equilibrium, with their transfer of a behavioral economic concept, such as the endowment effect (e.g., Kahneman, Knetsch, & Thaler, 1990). As behavioral economists incorporate insights from, amongst others, cognitive psychology into economic theory, an advantage of the use of behavioral economic concepts in transfer studies in economics education could be an increased relevance and authenticity of the contexts presented to the students. These topics will be elaborated on in Chapters 5 and 6.

Although the contribution of economic classroom experiments to the transfer of economic concepts is critically evaluated here, the present study shows that secondary school students can be trained to compare a variety of situations from which they can generate
abstractions. This may prepare them for an array of transfer situations they will face later on in life (cf. Salomon & Perkins, 1989). In turn, this may contribute to an increased economic literacy of the public in the future.
REFERENCES


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CHAPTER 5
CHAPTER 5

FULLY RATIONAL OR RATIONAL FOOLS?  
ELABORATING THE IMPORTANCE OF BEHAVIORAL ECONOMICS FOR THE  
ECONOMIC LITERACY OF STUDENTS IN SECONDARY EDUCATION

“How selfish soever man may be supposed, there are evidently some principles in his nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it except the pleasure of seeing it”  
(Smith, 1759/2002, p. 11)
5.1 INTRODUCTION

As described in Chapter 1, someone’s ability to recognize and apply economic concepts in ordinary situations is often referred to as economic literacy. The three empirical studies described in this thesis so far explored how economic classroom experiments, being interactive teaching/learning exercises, can support the economic literacy of secondary school students. Participating in economic classroom experiments seemed favorable mainly for acquiring knowledge of basic economic concepts, which is the first component of economic literacy (Chapter 2). With regard to the economic reasoning ability of the students, which is the second aspect of economic literacy, observing economic classroom experiments and analyzing experimental data seemed more beneficial than participating in the experiments (Chapter 3). The third and last component of economic literacy, namely the transfer of an economic concept across contexts in a process of analogical reasoning, seemed supported best by reading and comparing stories instead of by participating in an experiment and comparing that experience with written stories (Chapter 4). The central economic content in each of these studies was the microeconomic concept market. In essence this concept refers to a situation in which suppliers and demanders engage in an exchange process by means of which a price is established at a certain equilibrium (Schotter, 2003). As such, the concept market is part of economics curricula worldwide (e.g., Department for Education [DfE], 2014; Siegfried et al., 2010; Stolze, 2011; Teulings et al., 2005) and associated with standard neoclassical economic theory (e.g., Schotter, 2003).

As portrayed in Chapter 1, neoclassical economics consists of a body of theorems, mathematical tools, and assumptions (Bruni & Sugden, 2007; Camerer, 1999; Camerer, Loewenstein, & Rabin, 2004). At the core of neoclassical economics is the adherence to a “holy trinity” of rationality, self-interest, and equilibrium (Colander, Holt, & Rosser, 2004). A personification of these assumptions can be found in the iconic homo economicus: A self-interested, fully rational human being who calculates himself faultlessly into optimal choices...
Almost a century ago, however, *homo economicus* was described also as a creature “lacking the complex and irrational features of the human figure” (Tugwell, 1922, p. 317). The (un)realism of the neoclassical representation of human behavior has been heavily debated ever since. Prominent in this debate was Friedman, who argued that even unrealistic assumptions should not be considered problematic as long as the accompanying theory or model generates accurate predictions (Friedman, 1966). This so-called “F(riedman)-twist” made it possible for economists to disregard psychological insights on human behavior as long as the standard assumptions in economic models allowed for tractable analyses and “positive” science (Camerer, 1999; Camerer, 2005; Heukelom, 2014; Kahneman, 2003a; Sent, 2004).

Worldwide, secondary school economics curricula specify the use of neoclassical models (e.g., DfE, 2014; Siegfried et al., 2010; Stolze, 2011). Students use these general models to describe, predict, and analyze economic behavior. Analytic activities such as these may prepare them for future economics education, but do they also prepare for economic decision making in real life? As indicated in Chapter 1, research points out that the economic literacy of people is rather limited despite having attended economics classes (e.g., Walstad & Rebeck, 2002). It can be argued that the latter may be induced, at least partly, by the use of neoclassical models during economics class. As these models can be considered abstractions of aspects of reality that rely on assumptions, these models tend to deviate from everyday economic matters. As such, what has been learned during class may hardly be recognized or applied directly in everyday life situations by the students. Hence, the question arises to which extent addressing a mainly neoclassical framework during class contributes to the economic literacy of students.

Alternatively, addressing insights emerging from behavioral economics in secondary education may narrow the gap between what is learned during economics education on the one hand, and real world economic behavior on the other. Behavioral economists advance the understanding of real life economic behavior from the angle of, amongst others, cognitive...
psychology (e.g., Camerer, 1999). Research in the field of behavioral economics shows that the behavior of people in real world situations often deviates from human behavior as modeled in neoclassical economic theory (Engelhardt, 2011; Kahneman 2003a; Tversky & Kahneman, 1974). During the last decades, behavioral economic laboratory experiments and field observations have fostered the general understanding of the forces underlying people’s economic choice and decision making processes (e.g., Santos, 2011; Wilkinson & Klaes, 2012). This thesis investigates how the economic literacy of students can be supported. Because of its focus on individual choice and decision making, exploring the behavioral economic perspective is therefore preferable over alternative approaches such as institutional economics\(^{21}\) (e.g., North, 1990; Rutherford, 1994) or evolutionary economics\(^{22}\) (e.g., Nelson & Winter, 1982).

Taken together, the current chapter elaborates the proposition that insights emerging from behavioral economics provide an indispensable \textit{addition} to the content knowledge that is present in secondary school economics curricula at the moment. Section 5.2 of this chapter illustrates the emergence and significance of behavioral economics. Subsequently, section 5.3 elaborates the importance of behavioral economics for the economic literacy of students within the context of a secondary school curriculum.

5.2 FROM HOMO ECONOMICUS TO HOMO BEHAVIORAL ECONOMICUS

Despite of the interest some economists showed in factors underlying real world economic behavior “psychologists were \textit{persona non grata} in economists’ circles” (Wilkinson & Klaes, 2012, p. 13) during the first half of the twentieth century. By the 1940s, economics could be characterized as a “toolbox discipline” that consisted of a basic set of technical models and statistical methods that allowed economists to provide a wide array of disciplines with “objective” policy advice (Morgan & Rutherford, 1998). Not only had these models and methods been proven useful during wartime (Morgan & Rutherford, 1998), also the ability to provide value-free policy recommendations was especially important because of the emerging
tensions between communist and capitalist viewpoints in postwar politics (Morgan & Rutherford, 1998). As a result, by the early 1950s the neoclassical approach to economics seemed to be based on a strong belief in the power of free markets, and to rely heavily on the formal analysis of logical inferences drawn from assumptions (Camerer, 1999; Morgan & Rutherford, 1998). This is why economics could be regarded “an epistemology of generalized characterizations” (Heukelom, 2014, p. 6). Boosted by technical developments such as the calculation power of computers, mathematics and econometrics became important for formal economic analyses from the 1950s onwards (Wilkinson & Klaes, 2012).

Although the majority of economists drew inferences from neoclassical assumptions until the 1960s (Heukelom, 2014), slowly but surely arguments emerged in favor of grounding economic theory in real life observations as well. In the aftermath of the cognitive revolution in the 1960s, there was an increased recognition of the human mind, human perception, reasoning ability, and mental functions among behavioral scientists (e.g., Angner, 2012; Camerer et al., 2004). All of these can be considered necessary for understanding economic behavior. Important contributions in the borderland between psychology and economics can be attributed to Herbert Simon. He suggested, amongst others, to take the empirically established, limited capacities of real-world people as a starting point for economic theory (e.g., Sent, 2004; Simon, 1959). This notion of bounded rationality should have provided economics with “a fuller picture of economic man” (Simon, 1959, p. 279). However, Simon framed his ideas as a case against standard approaches to economics (Camerer et al., 2004) and did not provide formal proof for the necessity of replacing the assumption of perfect rationality with bounded rationality (Cartwright, 2011; Sent, 2004). Moreover, as economists had just picked up sophisticated mathematical approaches to advance their economic models, they were not ready for such a revolution yet (Camerer, 1999; Cartwright, 2011; Sent, 2004). Together, these factors contributed to the failure of grounding economic theory in more realistic observations of human behavior at that time.
During the 1970s and 1980s, cognitive psychologists who had been studying economic judgment and decision making reached interesting insights (Angner, 2012; Camerer, 1999). Famous is the research by Tversky and Kahneman (1974), who observed that people tend to reach economic decisions via the use of heuristics, or simple rules of thumb, instead of by means of their rational and faultless calculations of optimal choices. The use of such heuristics, however, may lead to judgmental errors due to several cognitive biases, and may result in less optimal outcomes. Hence, research emerging from the heuristics and biases program makes clear that the actual behavior of people deviated from the optimal behavior assumed by economists (e.g., Engelhardt, 2011; Kahneman, 2003b; Mullainathan & Thaler, 2000; Pesendorfer, 2006; Rabin, 1998; Rabin, 2002; Sent, 2004). This increased the necessity to come up with new economic theories that could account for human behavior. Further research culminated in the development of, amongst others, prospect theory. This theory poses that decisions arise from people’s weighing of gains and losses from their initial situation or reference point (Kahneman & Tversky, 1979).

The approach by means of which Tversky and Kahneman tried to advance economics can be characterized as “working constructively with the standard economic model to get a better understanding of economic behavior” (Cartwright, 2011, p. 4). Behavioral economists today follow a similar approach by taking existing economic theory as a starting point. Carefully designed economic laboratory experiments and other methods such as simulations or questionnaires, allow behavioral economists to investigate and identify possible deviations from the standard economic model (Angner, 2012; Heukelom, 2011; Santos, 2011; Sent, 2004; Weber & Camerer, 2006; see also Chapter 1)23. Once empirical results have indicated anomalies from formal economic theory, behavioral economists try to reformulate aspects of economic theory based on their empirical findings (Angner, 2012; Camerer et al., 2004; Weber & Camerer, 2006; Sent, 2004). In this way, behavioral economic research contributes to the
“adjustment process” by means of which economic theory becomes more aligned with observations of economic behavior in everyday life (Altman, n.d.; Santos, 2011).

The behavioral economic research process also illustrates a tight connection between empirical research and theoretical modeling (cf. Heukelom, 2011). This seems a main factor underlying the more widely acceptance of the current approaches to economists as opposed to the strategies initiated by Simon in the 1950s (Sent, 2004) or the pleas by Katona (1980), Cyert and Simon (1983), and Hursh (1984) in the early 1980s. Another reason why behavioral approaches to economics seem more broadly acknowledged now than they were in the 1950s and 1960s is because these provide alternatives for the problems that economists faced in the last decades (see Sent, 2004).

At the moment, behavioral economic research has identified a whole range of ways in which the behavior of people deviates from standard neoclassical theory (Camerer, 1999; Rabin, 1998; Rabin, 2002). Mullainathan and Thaler (2000) depict these deviations in terms of bounded rationality, bounded willpower, and bounded self-interest. The first aspect describes that the limited cognitive abilities of people refrain them from reaching well-calculated optimal choices (see also Engelhardt, 2011; Rabin, 1998; Tversky & Kahneman, 1974). Bounded willpower refers to the observation that people may not always reach decisions that are in their own long-run interest. Mullainathan and Thaler (2000) illustrate this phenomenon by referring to the research by Camerer, Babcock, Loewenstein, and Thaler (1997), who observed that instead of maximizing their future wealth, New York taxi drivers quit early on rainy days notwithstanding the large demand for their services on such days. Finally, bounded self-interest indicates that people seem to care about social aspects and other people, instead of pursuing their own benefits only (Mullainathan & Thaler, 2000).

Restrictions to rationality in human decision making such as these have been witnessed not only in real life situations but in economic laboratory settings as well. A major factor of influence seems to be the social preferences of people, such as reciprocity, reputation, or
fairness (for an overview, see Fehr & Schmidt, 2003). As an example, it has been observed in ultimatum games that individuals turn down profitable yet unfair offers (Diamond & Vartiainen, 2007; Rabin, 1993). During an ultimatum game, an amount of money (e.g., €10) is assigned to a pair of anonymous players. One player is a proposer, who suggests a certain division of the €10 between the two players in any combination she desires, such as (€10; €0) or (€7; €3). The other player is the responder. The responder has the right to accept or reject the offer made by the proposer. If the responder accepts the offer, both players receive the amounts of money according to the division proposed. However, if the responder rejects the offer, both players end up empty-handed (e.g., Cartwright, 2011; Grol, 2012). Laboratory experiments show that the power to punish others by rejecting an offer may outweigh the rational choice to accept even a small offer (e.g., Brosig, Weimann, & Yang, 2004). From a neoclassical economic viewpoint, going home empty-handed is not considered the optimal outcome of the game, however, from a behavioral economic point of view, rejecting the offer may turn out to be a satisfying choice which can be worth to be made due to the social preferences hold by the participants such as fairness, reputation, or reciprocity.

Studies such as these illustrate that real world decisions often deviate from the ways predicted by neoclassical economic models, even after eliminating all other factors or informing people about their own limited capacities (e.g., Kahneman, 2011). Despite the positions held by a share of economists that “[p]opulating economic models with ‘flesh-and-blood human beings,’ was never the objective of economists” (Gul & Pesendorfer, 2005, p. 43) and that “economic models can only be evaluated on their own terms, with respect to their own objectives and evidence” (Gul & Pesendorfer, 2005, p. 43), economics seems to move away gradually “from theorizing about how people should behave to theorizing about how they do behave” (Camerer, 1999, p. 10577).

The addition of more realistic psychological foundations to economic theory (e.g., Camerer, 1999; Diamond & Vartiainen, 2007; Sent, 2004) also implies the emergence of a new
picture of economic man. This *homo behavioral economics* may be described as a boundedly rational human being who tries to reach choices that may satisfy him and that are not only guided by self-interest. This not only means a relaxation of elements that were central to neoclassical economics once (cf. Colander et al., 2004), it also indicates that the research by behavioral economists contributes to changing the discipline of economics itself (Colander, Holt, & Rosser, 2010). As several of these studies indicate the importance of behavioral economics for reaching decisions in everyday life\(^{24}\), the next section elaborates the importance of behavioral economics for the economic literacy of secondary school students.

### 5.3 Behavioral Economics and the Curriculum

Worldwide, economics teachers in secondary education aim at increasing the economic literacy of their students. On the level of secondary education, economics curricula are often designed to provide students with “a pair of glasses” that enable them to observe and interpret individual behavior and real world phenomena from an economic point of view (e.g., DfE, 2014; Siegfried et al., 2010; Teulings et al., 2005). Notwithstanding the developments and findings sketched in section 5.2, these curricula seem to lack much of the insights emerging from behavioral economics (e.g., DfE, 2014; Siegfried et al., 2010; Teulings et al., 2005). Even a recent call for expanding the economics curriculum in a “broader, more reality-based, and historically grounded [way]” (Peterson, 2013, p. 404) does not seem to result in the formal introduction of a behavioral perspective to economics education in secondary schools yet. As a consequence, the economics glasses of students seem to consist predominantly of neoclassical economic lenses.

The proposition of the current chapter is that the economics glasses of students in secondary education may benefit from adding a behavioral economic lens *in addition to* the neoclassical economic lens that is present in the curricula at this moment. As the behavioral perspective provides economics with more realistic psychological foundations (see section 5.2),
adding behavioral economic concepts to the secondary school curriculum may better prepare students for future situations in which they may be asked to reach economic decisions. It may foster the ability of students to recall and use behavioral economic concepts in future daily live situations. As pointed out in Chapter 1, this ability is at the heart of economic literacy (Salemi, 2005).

As behavioral economic knowledge claims are often fuelled by experimental findings (e.g., Santos, 2011), using experiments in economics class may further enhance students’ understanding of a specific behavioral economic phenomenon through their own experiences. This is why Chapter 6 explores how the participation of secondary school students in a behavioral economic experiment can support the knowledge acquisition and transfer of a behavioral economic concept across contexts.
REFERENCES


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CHAPTER 6
CHAPTER 6

PARTICIPATION IN A BEHAVIORAL ECONOMIC EXPERIMENT
ADVANCES FAR TRANSFER

ABSTRACT
Although awareness of the behavioral mechanisms underlying people’s choice behavior might help students to reach informed economic decisions later on in life, insights from behavioral economics seem hardly present in economics curricula in secondary education. The present study investigates how secondary school students can be supported in gaining knowledge of a behavioral economic concept and in transferring this concept across contexts through participation in an economic classroom experiment. Two research conditions are set up in a sample of 222 students. Students in the experiment condition \( n = 94 \) participate in an economic experiment first. Hereafter, they read two stories and compare these with each other. Students in the stories condition \( n = 128 \) read and compare three stories. A posttest measures transfer in two new contexts and the answers that are collected during the lesson provide insights in the comparison processes of the students. Students in the stories condition score significantly better at an intermediate transfer task that resembles the learning contexts to a great extent, whereas students in the experiment condition perform significantly better at a far transfer task which comprises of a context that captures distracting information. Possible explanations for these findings are discussed.

KEY WORDS
Analogical reasoning, behavioral economics; economic experiment; endowment effect; secondary education; transfer.

JEL-CLASSIFICATION
A21, B05, D00.

SUBMITTED
6.1 INTRODUCTION

As pointed out in Chapter 1, a considerable number of adults does not seem to know much about economic issues, even though many of them attended economics classes once (e.g., Hansen, Salemi, & Siegfried, 2002; Walstad & Rebeck, 2002). People’s understanding of economic matters is often referred to as economic literacy. Lack of economic literacy makes people vulnerable when they are faced with economic situations in everyday life. The latter may be illustrated by the following example. In a study on car buying behavior, consumers were assigned to each of two groups. Customers in the first group were presented with a full-option car and were asked to eradicate all unwanted options. A second group of customers was presented with an identical car without any options. They were asked to add all options they desired. Notwithstanding the premise that preferences and thus outcomes would be equal across groups, consumers in the first group ended up with far more options than consumers in the second group (see Schwartz, 2004). An explanation for this discrepancy may be found in peoples’ unawareness of the behavioral mechanisms that govern their judgment and decision making on the one hand, and in their inability to recognize and apply these mechanisms in new situations on the other.

A main mechanism affecting the behavior of customers in the car buying case is the so-called endowment effect, which states that people attach more value to an object once they feel ownership over it (e.g., Kahneman, 2011; Thaler, 1980). Following this line of thought, the endowment effect may have led the first group of potential car buyers to think they already owned the options presented to them. This group would perceive giving up options as a loss, whereas each option added to the car was perceived as a gain by customers in the second group. Prospect theory indicates that people reach their decisions based on their valuation of possible losses and gains (Kahneman & Tversky, 1979). The theory states, amongst others, that people tend to assign a larger weight to losses than to gains. The first group of customers in the car buying case is confronted with feelings of loss. They do not like to get rid of too many options...
and end up with a great many options and thus a costlier car than is the case with the second group of customers who perceive each option added as a gain (Schwartz, 2004). Loss aversion thus seems an important factor underlying the endowment effect (e.g., Rabin, 2002).

Insights such as loss aversion and the endowment effect originate from behavioral economic research. As described in Chapter 5, behavioral economists aim at enriching standard neoclassical economic theory by using insights from cognitive psychology, social psychology, and anthropology. A recognition of the importance of behavioral economics can be regarded awarding Daniel Kahneman The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel in 2002. He received this prize for the research he did with Amos Tversky (The Royal Swedish Academy of Sciences [RSAS], 2002). The other winner of this prize in 2002 was Vernon Smith and his groundbreaking work in experimental economics. Notwithstanding the significance of behavioral economics, its insights have hardly trickled down to the level of secondary education. Economics curricula and textbooks today still seem focused on neoclassical economics (e.g., Grol & Sent, 2012; Kahneman, 2003). This can even be read explicitly in the United States’ Voluntary National Content Standards: “The final standards reflect the view of a large majority of economists today in favor of a ‘neoclassical model’ of economic behavior” (Siegfried et al., 2010, p.vi). The underlying argumentation is that “[i]ncluding strongly held minority views of economic processes and concepts would have confused and frustrated teachers and students who would then be left with the responsibility of sorting the qualifications and alternatives without a sufficient foundation to do so” (Siegfried et al., 2010, p.vi). As a result, the US standards include hardly any propositions held by behavioral economists. A merely marginal attention to behavioral economics can also be observed in several other secondary school curricula worldwide (e.g., DfE, 2014; Stolze, 2011; Teulings et al., 2005). This indicates that secondary school students are likely to know only little about behavioral economic concepts.
As it is to be expected that students will be confronted with behavioral economic concepts in situations later on in life, they may benefit from gaining knowledge of such concepts and from developing the ability to recognize these in a wide variety of contexts. Then, students would be able to recognize economic behavior also in situations that deviate from the contexts they encountered during class. Addressing a behavioral economic phenomenon such as the endowment effect seems especially important during secondary education, as this might be the last moment in which students attend formal economics education at all (cf. Walstad & Soper, 1988). This is why the present study explores how secondary school students can be supported in gaining knowledge of the behavioral economic endowment effect and in transferring it across contexts. Following this purpose, in section 6.2 it is addressed how students could be supported in gaining knowledge of the endowment effect and in transferring this behavioral economic concept across contexts. In section 6.3 the research method and procedures are elaborated. The results are described in section 6.4 and these are discussed and elaborated in section 6.5.

6.2 MASTERING THE ENDOWMENT EFFECT

The endowment effect originates in behavioral economic research (e.g., Thaler, 1980; see also Kahneman, Knetsch, & Thaler, 1990). Behavioral economists explore the real economic judgment and decision making behavior of people instead of reasoning along rationality assumptions (e.g., Angner, 2012; Rabin, 2002). Methods for empirical research in behavioral economics include experiments in the laboratory (e.g., Friedman & Cassar, 2004; Smith, 1976; Smith, 1989) and the field (e.g., Carpenter, Harrison, & List, 2005). The inductive method of experimentation allows for modeling or simulating a specific environment in which the economic behavior of the research participants can be observed (e.g., Fiore, 2009; Mäki, 2005; Santos, 2011). It has been pointed out in Chapter 1 that economic experiments also have found their way into the classroom. Because economics curricula in secondary education seem to focus at neoclassical economic theory (e.g., Siegfried, 2010) these economic classroom
experiments are likely to concern standard economic concepts such as supply, demand, or market equilibrium.

Adding behavioral economic experiments to the economics curricula in secondary education, however, may provide students with an authentic learning setting in which they can become familiar with concepts from behavioral economics, such as the endowment effect, as well. Authentic approaches to teaching and learning present students with activities that represent real-life tasks in realistic contexts (Brown, Collins, & Duguid, 1989; Collins, 1988; McKenzie et al., 2002; Galarneau, 2005; Stein, Isaacs, & Andrews, 2004). This means that teaching/learning activities are framed by meaningful personal experiences of students on the one hand (cf. Dewey, 1938/1997), and are grounded in the disciplinary structure these originate from on the other (e.g., Stein et al., 2004). Students enrolled in behavioral economic experiments can gain first-hand experiences instead of merely reading about the experiences or theories of others (cf. Dewey, 1938/1997; Herrington & Oliver, 2000). As behavioral economic experiments are applied as an empirical research method in economics, these can provide teachers with an authentic approach to teaching and learning from a scientific point of view. Moreover, behavioral economic experiments replicate a part of the real world in which students can participate from an economic perspective. This increases the authenticity of the learning environment even further.

The first aim of the present study is to explore if participation in a behavioral economic experiment supports secondary school students in gaining knowledge of a behavioral economic concept, namely the endowment effect. As described in Chapter 4, students can be guided in identifying and describing an economic concept through a process of analogical reasoning. In essence, the latter encompasses the ability to point out the relevant similarities between a familiar source case and one or more new target cases (Richland, Stigler, & Holyoak, 2012). Research in the field of analogical reasoning reveals at least four pointers that seem helpful for designing a teaching/learning environment that supports analogical reasoning.
First, participants who are given a hint to use the source case to solve the target problem are better at solving the transfer task than students who are not offered a hint (Gick & Holyoak, 1983). Second, students who receive two source cases perform better at the transfer task than students who are given only one source case (Gick & Holyoak, 1983). Richland et al. (2012) point out that the comparison of two or more cases allows students to grasp the features of the problem better, improve their schemas, and thus reach transfer more accurately. In line with the latter suggestion, Catrambone and Holyoak (1989) show that the use of three cases is to be preferred over two cases.

Third, explicit “schema-oriented” questions can direct students in detecting and formulating structural communalities (Catrambone & Holyoak, 1989) and may refrain them from focusing on directly observable surface similarities. Identifying structural communalities and formulating these similarities in abstract and general terms is considered crucial for transfer (Chi & Van Lehn, 2012; Day & Goldstone, 2012; Gentner, Loewenstein, & Thompson, 2003; Gentner & Medina, 1998) as it allows students to recognize and use these in a wider set of contexts than just the specific one in which these are learned (e.g., Salomon & Perkins, 1989).

Fourth, it is argued that simple representations seem helpful for transfer, but that real-world examples that are too context-rich can even impair transfer (Bransford & Schwartz, 1999; Day & Goldstone, 2012). Cases presented to students should thus model real-world situations (Koedinger & Roll, 2011). To provide students with real-world contexts that “protect them from harmful or irrelevant elements that could impede, rather than support, their learning” (Stein et al., 2004, p. 240), previous research made use of written stories (e.g., Catrambone & Holyoak, 1989; Gick, 1985). These stories assisted the students in the process of analogical reasoning by modeling key-features of the overarching structural similarities between cases. As experiments can be regarded as models as well (see Mäki, 2005), behavioral economic experiments could be applied to create a simplified context by means of which a specific behavioral economic concept can be illustrated to the students. To the best of our knowledge, effects of using
behavioral economic experiments for gaining knowledge of a behavioral economic concept through a process of analogical reasoning in the context of secondary education have not been reported yet.

The second aim of the present study is to explore if participation in a behavioral economic experiment can also foster transfer of the endowment effect across contexts. Transfer can be defined as someone’s ability to use certain knowledge or skills in novel situations (e.g., Alexander & Murphy, 1999; Detterman, 1993; Simons, 1999; Stark, Mandl, Gruber, & Renkl, 1999). Following the transfer taxonomy by Barnett and Ceci (2002), the transfer of a variety of aspects of learning can occur on a continuum ranging from near to far. Near transfer situations resemble the learning situation to a large degree, whereas far transfer situations differ quite a lot from those encountered when encountering the initial cases. Intermediate transfer can be positioned in between near and far transfer.

Previous research has studied the transfer of knowledge and skills (e.g., Griffin, 1995; Halpern, 1998). Often, these studies take a direct application-approach in which individual students have to apply what is learned during class by completing a posttest (Bransford & Schwartz, 1999). These posttests may regard the recognition or application of knowledge in near, intermediate, or far transfer situations. As has been pointed out in Chapter 4 and in line with Bransford and Schwartz (1999), Kneppers (2007) suggests to study the ability of secondary school students to compare different situations which share an overarching similar structure with each other as well. This implies that the processes of analogical reasoning, in which students compare and contrast situations and by means of which they formulate (overarching) abstractions, should be captured during class as well. The latter may be achieved by applying process measurements such as video cameras, audio recordings, or the collection of written student materials. To the best of our knowledge, both the processes and the effects of behavioral economic experiments on the transfer of a behavioral economic concept across contexts by secondary school students have not been reported yet.
Taken together, for the purpose of increasing the economic literacy of students, the present study addresses the research question to which extent participation in a behavioral economic experiment supports the ability of secondary school students to identify and formulate the structural overarching similarity between cases, and to recognize this behavioral economic concept in both an intermediate and a far transfer situation. The research hypotheses are as follows:

Hypothesis 1: Participation in an endowment effect experiment that is supported by stories and explicit questions better enables students to identify and formulate a behavioral economic concept than does the reading and comparing of stories only.

Hypothesis 2: Participation in an endowment effect experiment that is supported by stories and explicit questions better enables students to recognize a behavioral economic concept in both an intermediate and a far transfer situation than does the reading and comparing of stories only.

6.3 METHOD
6.3.1 PARTICIPANTS
Recruited via the professional network of the investigators, schools for upper general secondary education were randomly assigned to the Experiment condition (4 classes), and the Stories condition (6 classes). Only one condition per school was applied. As students were in the year before their final examination, they had acquired quite similar and rather advanced knowledge of general economic principles. Nevertheless, none of the participating students had been taught or learned about the endowment effect during formal education. The research, in which 222 students participated, took place in June 2014. Their average age was 16.5 years (SD=0.8) and 99 of them (44.6%) were female. Demographic data, such as gender, age, and grade point averages (GPAs) were collected using official school records (cf. Maxwell & Lopus, 1994). For the purpose of measuring initial student motivation with regard to the school subject of...
economics, a slightly modified version of the Attitude Scale towards Mathematics (ASM) questionnaire (Martinot, Kuhlemeier, & Feenstra, 1988) was filled out by the students. In the adapted questionnaire, the term “mathematics” was replaced with “economics”. Students pointed out to which extent they agreed with written declarations such as: “I consider economics to be of little use”. The 4-point Likert scale ranged from “totally disagree” to “totally agree”. Reliability analysis showed a good internal consistency of the four constructs underlying the ASM: Pleasure (α=.85), no fear or difficulty (α=.86), interest and devotion (α=.77), and profit and relevance (α=.79). Table 6.1 shows summary statistics regarding all collected data on demographics and learning preconditions. ANOVAs and cross tabulations showed no significant mean differences between the two research conditions with regard to these variables, indicating a successful randomization.
## Table 6.1 Demographic Data and Learning Preconditions

<table>
<thead>
<tr>
<th>Variables</th>
<th>Total All Conditions</th>
<th>Experiment Condition</th>
<th>Stories Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$N=222$</td>
<td>$N=94$</td>
<td>$N=128$</td>
</tr>
<tr>
<td>Age</td>
<td>16.5 (0.8)</td>
<td>16.4 (0.7)</td>
<td>16.6 (0.8)</td>
</tr>
<tr>
<td>Female</td>
<td>99 (44.6)</td>
<td>40 (43.0)</td>
<td>59 (46.1)</td>
</tr>
<tr>
<td>GPA Economics</td>
<td>6.4 (0.9)</td>
<td>6.5 (1.0)</td>
<td>6.3 (0.9)</td>
</tr>
<tr>
<td>GPA Mathematics</td>
<td>6.3 (0.9)</td>
<td>6.5 (1.0)</td>
<td>6.2 (0.9)</td>
</tr>
<tr>
<td>GPA Dutch</td>
<td>6.4 (0.7)</td>
<td>6.4 (0.7)</td>
<td>6.3 (0.7)</td>
</tr>
<tr>
<td>ASM Pleasure</td>
<td>23.3 (4.8)</td>
<td>24.6 (5.1)</td>
<td>22.3 (4.4)</td>
</tr>
<tr>
<td>ASM No fear / difficulty</td>
<td>25.3 (4.9)</td>
<td>25.6 (5.1)</td>
<td>25.2 (4.7)</td>
</tr>
<tr>
<td>ASM Interest / devotion</td>
<td>17.8 (4.4)</td>
<td>19.5 (4.2)</td>
<td>16.6 (4.2)</td>
</tr>
<tr>
<td>ASM Profit / relevance</td>
<td>25.5 (3.8)</td>
<td>26.6 (3.5)</td>
<td>24.4 (3.8)</td>
</tr>
</tbody>
</table>

*Notes.* All data are reported [mean (SD)], except for Female: [Number of female students (%)]; Age: The age of the respondent; Female: Number of female students; GPA: Grade point average on a scale ranging from 1 (lowest possible score) to 10 (highest possible score); ASM: The slightly adapted version of the Attitude Scale towards Mathematics (Martinot et al., 1988).
6.3.2 RESEARCH DESIGN

To address the research question and test the hypotheses, two research conditions were set up. Based on the literature discussed in section 6.2, teaching/learning activities in both research conditions were designed to support analogical reasoning via multiple sources, the use of an array of simplified contexts, and the provision of explicit questions that guide students when they compare a variety of situations and formulate abstractions regarding the overarching similar structure of these cases.

In the experiment condition, all students participated in an endowment effect experiment first. This experiment was inspired by an experiment run by Kahneman et al. (1990). In the present version of the experiment, half of the students was randomly provided with coffee mugs. The other half of the students was not provided with mugs. Students were not informed about the value of these hand painted mugs from the famous brand Royal Boch which had a retail price of €6.49 each. All students also received a form corresponding to their role as either seller or buyer. These forms contained the following instructions (see Box 6.1).

<table>
<thead>
<tr>
<th>Box 6.1 Instructions for Students in the Coffee Mug Experiment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Instructions for students owning a coffee mug</strong></td>
</tr>
<tr>
<td>You now own this coffee mug. You can take the mug home if you</td>
</tr>
<tr>
<td>would like to. But you will also be given the opportunity to</td>
</tr>
<tr>
<td>sell this mug if the price, that will be announced later,</td>
</tr>
<tr>
<td>is acceptable for you. Please indicate, by means of marking</td>
</tr>
<tr>
<td>an ‘X’ in the appropriate checkbox for each of the following</td>
</tr>
<tr>
<td>prices, ranging from €0.25 to €8.75, whether or not you are</td>
</tr>
<tr>
<td>willing to sell your mug for that price.</td>
</tr>
<tr>
<td><strong>Instructions for students not owning a mug</strong></td>
</tr>
<tr>
<td>You now do not own a coffee mug, as some of your fellow</td>
</tr>
<tr>
<td>students do. However, you will be given the opportunity to</td>
</tr>
<tr>
<td>buy a mug and take it home with you if the price, that will</td>
</tr>
<tr>
<td>be announced later, is acceptable for you. Please indicate,</td>
</tr>
<tr>
<td>by means of marking an ‘X’ in the appropriate checkbox for</td>
</tr>
<tr>
<td>each of the following prices, ranging from €0.25 to €8.75,</td>
</tr>
<tr>
<td>whether or not you are willing to buy a mug for that price.</td>
</tr>
</tbody>
</table>

*Note. Inspired by Kahneman et al. (1990).*
It was announced by the teacher that a market price would be calculated from the prices indicated by the students on their forms. At that price, real payments had to be made, and mugs had to be exchanged. All students had to fill out their forms individually. By doing so, they indicated at which price they were willing to sell or buy a mug. Hereafter, the teacher calculated the willingness to accept (WTA) and the willingness to pay (WTP) of the students. During the debriefing, the teacher discussed briefly that supply and demand resulted in market prices in this particular experiment and a (possible) gap between WTA and WTP. As it was up to the students to formulate their own description of this phenomenon later on in the lesson, teachers were instructed not to label the WTA-WTP-gap with any term at all and in particular to avoid using terms such as “exchange asymmetry” or “endowment effect”. Then, students in the experiment condition individually read stories 2 and 3 as listed in Box A.6.1 (appendix). In the stories condition no experiment was played. Instead, all students individually read three stories, which can be considered a standard approach in analogical reasoning research (e.g., Gick & Holyoak, 1983). These stories are portrayed in Box A.6.1 (appendix).

Next, students in the two research conditions filled in a hand-out. These hand-outs guided the students in the process of comparing and contrasting the three situations they were presented with and assisted them in formulating the overarching structural similarities between the three situations (see subsection 6.3.3.1 for more details). Finally, students were given the opportunity to discuss their findings in pairs, expecting that dialogue could improve the quality of their answers (e.g., Kneppers, 2007; Mercer, Dawes, Wegerif, & Sams, 2004). The teacher made pairs out of students who sat side by side. To regulate the peer conversations, eight ground rules for communication were explained and handed out to the students (e.g., Mercer, 1995; Wegerif, 2001; see also Chapter 3, Box 3.3). As an example, one of these rules regarded the necessity of providing arguments for each statement made by a student.
6.3.3 MEASURES AND COVARIATES

6.3.3.1 PROCESS MEASURE: CONCEPT IDENTIFICATION

To measure the extent to which students were able to identify the endowment effect from the three situations they encountered during class, they were offered a hand-out that consisted of four questions. Inspired by Catrambone and Holyoak (1989), these questions were designed to guide students in their comparison of the three situations. Examples of these questions were: “Please replace the specific terms ‘coffee mug possessors’ from situation 1, ‘golf players who make a birdie’ from situation 2, and ‘basketball ticket owners’ from situation 3 by a more general term that could be used in all three situations”, and: “Please formulate an overarching concept that describes how the outcomes of the three situations resemble each other”.

After completion, the hand-ins were collected and analyzed, aiming at determining the overarching concepts as identified and formulated by the students. For the purpose of analysis, all available student answers were printed on cards. Two independent raters, blind for condition, sorted these cards into categories and labeled them. After discussing their individual set of labels together, raters reached consensus and created one final set of labels. Finally, they sorted the cards with student answers per label and calculated frequencies. An intra-class correlation coefficient (two way mixed model, absolute agreement, single measures) showed a good consistency amongst the raters: ICC=.942 (p=.002), 95% CI (0.53, 0.98).

6.3.3.2 OUTPUT MEASURE: TRANSFER

To measure transfer, a posttest was constructed that consisted of two different stories and accompanying test questions. The overarching concept that these stories shared was the endowment effect. This was the same concept with which the students worked during the previous lesson in which they compared three situations. The two stories are presented in Box 6.2.
Box 6.2  Two Stories in the Transfer Situation

<table>
<thead>
<tr>
<th>Intermediate transfer: Chimpanzee Story (1)</th>
<th>Far transfer: House For Sale Story (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>33 chimpanzees have lived for years in the zoo. Hence, their caretakers know that these monkeys are as fond of eating peanut butter as they are of eating frozen fruit. At the first Monday of the new year, the 33 chimpanzees were offered a portion of peanut butter. They were allowed to keep the portion of peanut butter or to return it to their caretakers and exchange it for a portion of frozen fruit. 28 chimpanzees chose the peanut butter. The next Monday, exact one week later, the 33 chimpanzees were offered a portion of frozen fruit. They were allowed to keep the portion of frozen fruit or to return it to their caretakers and exchange it for a portion of peanut butter. 14 chimpanzees chose the peanut butter.</td>
<td></td>
</tr>
<tr>
<td>In 1991, Sam and his wife Danielle decided to buy a 100-year-old house. To modernize the house, they acted out severe reconstruction activities in which they removed all inner walls, hence creating an “open” atmosphere. In 2007, Sam and his wife were reassigned to new jobs, which were located over 200 kilometers away from their house. Therefore, they decided that they wanted to sell the house, preferably as soon as possible. Around that time, the prices of houses had risen year after year. Sam and Danielle posted an advertisement online, and many people came to have a look at their modernized house, but no one placed a bid. People told Sam and Danielle that they disliked the house; they considered it not very cozy, because all inner walls were missing. Sam and Danielle opposed this view: “These people just do not have the right taste! There surely is someone out there for whom this house is the perfect spot.” As time went by, Sam and Danielle moved out to their new home, and had to pay all expenses for two houses now. Meanwhile, the growth of housing prices had diminished. Still, people made appointments to take a look at the house for sale, but they left as well – without placing a bid.</td>
<td></td>
</tr>
</tbody>
</table>

Notes. These two stories were inspired by, respectively, (1) behavioral research in chimpanzees by Brosnan et al. (2007) and (2) reflections on the challenges of ownership by Ariely (2008). All stories were written for educational purposes in secondary education. They are therefore not intended to reflect the precise research procedures or results of the aforementioned studies.

One of these stories was about chimpanzees and was inspired by Brosnan et al. (2007). This story illustrated the endowment effect by portraying that monkeys did not easily give up the food which they were offered initially. Students were asked to point out why the chimpanzees made seemingly different choices in the situations with which they were faced. Students were also asked to write down an economic concept that described this phenomenon. As the chimpanzee story presented the students with a situation that stated the reluctance of monkeys to give up the food which was offered to them, without providing many additional real-world details that could distract the students from identifying the endowment effect, it can be argued that the chimpanzee story required intermediate transfer.
The other story regarded a situation in which a house was for sale. Inspired by Ariely (2008), the endowment effect in this story was hidden in an information-rich context that included, amongst others, a short family history and a changing real-estate market. Students were asked to describe why the house in the story had not been sold yet. They also had to formulate an economic concept that described this phenomenon and were asked to come up with a suggestion that would help the family to sell their house in the near future. As this story consisted of an information-rich context from which students had to filter authentic, real-world details in order to identify the endowment effect, it can be argued that it required far transfer.

Two independent raters scored the student answers on the test questions blind for condition. A maximum of three points per case was awarded to the student answers. The intra-class correlation (two way mixed model, absolute agreement, single measures) between the raters was satisfactory: ICC = .82 (p<.001), 95% CI (0.745, 0.873).

6.3.4 PROCEDURE
To reduce experimenter-demand-effects (e.g., Zizzo, 2008), students were taught and tested by their own teacher. Before the study started, teachers received instructions regarding all teaching/learning materials and tests during a personal training with the principal researcher and a research assistant. The training involved an intensive elaboration of the teaching/learning materials and measurement instruments to ensure that each individual teacher was well aware how to perform the teaching/learning activities, which documents to hand out at which moment in time, and how to collect and hand-in the data afterwards. Hereafter, baseline data regarding demographics and learning preconditions were collected. In the first lesson, students attended the teaching/learning activities in one of the research conditions only. During the next class, scheduled within five days of the first meeting, all students took the individual transfer test.
6.4 RESULTS
6.4.1 PRE-ANALYSIS

The mug experiment in the experiment condition was offered to secondary school students to let them experience and observe the endowment effect. Therefore, this pre-analysis investigates the extent to which the endowment effect occurred during the experiment. Inspired by previous research (Kahneman, et al., 1990), the endowment effect was operationalized as the gap that occurs between willingness-to-accept (WTA) and willingness-to-pay (WTP). Table 6.2 shows the experimental output for each group that participated in the experiment.

<table>
<thead>
<tr>
<th>Group</th>
<th>N</th>
<th>WTP</th>
<th>WTA</th>
<th>Ratio</th>
<th>WTP</th>
<th>WTA</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>23</td>
<td>1.61</td>
<td>2.19</td>
<td>1.4</td>
<td>1.61</td>
<td>2.19</td>
<td>1.4</td>
</tr>
<tr>
<td>2</td>
<td>25</td>
<td>1.25</td>
<td>2.58</td>
<td>2.1</td>
<td>1.25</td>
<td>2.75</td>
<td>2.2</td>
</tr>
<tr>
<td>3</td>
<td>20</td>
<td>1.03</td>
<td>4.34</td>
<td>4.2</td>
<td>0.75</td>
<td>5.25</td>
<td>7.0</td>
</tr>
<tr>
<td>4</td>
<td>16</td>
<td>0.82</td>
<td>3.31</td>
<td>4.0</td>
<td>0.25</td>
<td>2.25</td>
<td>9.0</td>
</tr>
</tbody>
</table>

Table 6.2 Outcomes of the Coffee Mug Experiments

Notes: N: number of students in each experimental group; WTP: willingness-to-pay (in Euros); WTA: willingness-to-accept (in Euros); Ratio: calculated as WTA / WTP.

As can be calculated from Table 6.2, the mean WTA of €3.11 surpassed the mean WTP of €1.18 by a factor of 2.6. This indicates that secondary school students enrolled in the experiment condition were given the opportunity to experience and observe the gap occurring between WTA and WTP via their participation in the behavioral economic experiment.
6.4.2 CONCEPT IDENTIFICATION

The first research hypothesis stated that participation in an endowment effect experiment supported by two stories and explicit questions would better enable students to identify and formulate a behavioral economic concept describing the structural communality between situations than would the reading and comparing of three stories. During class, students were asked to compare and contrast three situations and to identify the overarching structural similarity by formulating a behavioral economic concept by using their own words. Although not all students completed their hand-ins, students in each of the two research conditions seemed able to formulate a concept of which they thought it summarized this similarity best. These student formulations are presented in Table 6.3.

The structural similarity between the three situations was described in standard economic terminology by 18% of the students in the experiment condition and an almost equal share of 20.8% of the students in the stories condition: *Prices are determined by supply and demand*. Although this formulation states a widely accepted neoclassical concept of market behavior, it does not acknowledge the existence of any endowment effect yet. The same accounts for the 13.1% of the students in the experiment condition and the 8.3% of the students in the stories condition who formulated the overarching concept in terms of a *personal profit*.

The suggestion that the expected market equilibrium is not reached was described by 21.3% of the students in the experiment condition and by a similar share of the students in the stories condition (22.2%). Although the idea of endowment seems nascent here, disciplinarians may argue that these student answers merely describe a consequence of the endowment effect and not the endowment effect itself.
Table 6.3  Student Descriptions of the Behavioral Economic Concept

<table>
<thead>
<tr>
<th>Student Formulation</th>
<th>Total All Conditions</th>
<th>Experiment Condition</th>
<th>Stories Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices are determined by supply and demand</td>
<td>26 (19.5)</td>
<td>11 (18.0)</td>
<td>15 (20.8)</td>
</tr>
<tr>
<td>Both sellers and buyers want to make a personal profit</td>
<td>14 (10.5)</td>
<td>8 (13.1)</td>
<td>6 (8.3)</td>
</tr>
<tr>
<td>Supply and demand do not always meet, hence there is no market equilibrium</td>
<td>29 (21.8)</td>
<td>13 (21.3)</td>
<td>16 (22.2)</td>
</tr>
<tr>
<td>The price one demands is higher than the willingness of others to pay for it</td>
<td>36 (27.1)</td>
<td>14 (23.0)</td>
<td>22 (30.6)</td>
</tr>
<tr>
<td>Other</td>
<td>28 (21.1)</td>
<td>15 (24.6)</td>
<td>13 (18.1)</td>
</tr>
<tr>
<td>No answer at all</td>
<td>89</td>
<td>33</td>
<td>56</td>
</tr>
</tbody>
</table>

Notes. All data are reported [total number (% of within group total)]. Students who did not provide an answer were excluded from the calculation of within group percentages.

Twenty-three per cent of the students in the Experiment condition and a somewhat larger share of 30.6% of the students in the Stories condition described the endowment effect by phrases such as: *The price one demands is higher than the willingness of others to pay for it*. This formulation can be regarded novice terminology for describing the endowment effect\(^{31}\). It illustrates that these students were able to identify and formulate that the structural communality that overarches the three situations has something to do with the gap that occurred between someone’s willingness-to-pay and her willingness-to-accept reward for giving up the product: The endowment effect.
6.4.3 TRANSFER

The second research hypothesis stated that participation in an endowment effect experiment supported by two stories and explicit questions would better enable students to recognize the endowment effect in both an intermediate and a far transfer context than would the reading and comparing of three stories. Student scores on the transfer tasks are presented in Table 6.4.

Table 6.4 Student Scores on Transfer Tasks

<table>
<thead>
<tr>
<th>Test Scores</th>
<th>Total All Conditions</th>
<th>Experiment Condition</th>
<th>Stories Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=222</td>
<td>N=94</td>
<td>N=128</td>
</tr>
<tr>
<td>Chimpanzee Story</td>
<td>0.26 (0.52)</td>
<td>0.16 (0.40)</td>
<td>0.32 (0.57)</td>
</tr>
<tr>
<td>(intermediate transfer)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>House for sale story</td>
<td>0.90 (0.42)</td>
<td>0.98 (0.42)</td>
<td>0.79 (0.39)</td>
</tr>
<tr>
<td>(far transfer)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note. All data are reported [mean (SD)].

With regard to recognizing the endowment effect in the chimpanzee story, students in the stories condition showed higher average scores (M=0.32, SD=0.57) than students in the experiment condition (M=0.16, SD=0.40). ANCOVA revealed a main effect of condition after adjusting for sex as confounder: $F(1, 190)=4.86, p=.029, \eta^2_p=.03$ ($R^2=.05, \text{adj.} R^2=.04$). Simple contrast analysis showed that students enrolled in the stories condition significantly outperformed students enrolled in the experiment condition with regard to their intermediate transfer scores (Stories vs. Experiment, contrast estimate=0.16, SE=0.07, $p=.029$).

With regard to the house for sale story, students in the experiment condition showed higher average scores (M=0.98, SD=0.42) than students in the stories condition (M=0.79, SD=0.39). ANCOVA revealed a main effect of condition after adjusting for age, GPA for economics, and ASM-scores regarding pleasure, no fear/difficulty, and profit/relevance as
confounders: $F(1, 166)=5.29, p=.023, \eta_p^2=.03$ ($R^2=.12, \text{adj.}R^2=.09$). Simple contrast analysis showed that students enrolled in the experiment condition significantly outperformed students enrolled in the stories condition to their far transfer scores (Experiment vs. Stories, contrast estimate $=0.15$, $SE=0.07$, $p=.023$).

### 6.5 DISCUSSION AND CONCLUSION

Central in this study was the behavioral economic endowment effect. This concept states that people attach more value to an object once they feel ownership over it. The endowment effect affects the economic behavior of people in a wide array of contexts. To increase the behavioral economic literacy of students in secondary education, the present study examined how secondary school students could be supported in gaining knowledge of the endowment effect and in transferring their knowledge of this concept across contexts through participation in a behavioral economic classroom experiment.

Two research conditions were set up to investigate the research question and to test the research hypotheses. The underlying assumption was that experiencing the endowment effect in an experiment first would promote the understanding of a behavioral concept as well as its subsequent recognition in transfer situations. In the experiment condition, 94 students participated in a behavioral economic experiment and then individually read two stories that covered the same overarching economic concept, namely the endowment effect. The 128 students enrolled in the stories condition read three stories regarding the endowment effect and did not take part in an experiment first.

The actual occurrence of the endowment effect in the experiment performed with secondary school students was established first. This finding illustrates that students in the experiment condition were in the position to discover the endowment effect. The average WTA/WTP-ratio of 2.6 was comparable to the ratios found in previous studies. Kahneman et al. (1990), for instance, found a median willingness to accept of $5.25 exceeding about twice...
the median willingness to pay of $2.25 in a similar experiment, and Carmon and Ariely (2000) found an overall WTP exceeding the WTA more than twice.

Hereafter, the hypotheses were tested that participation in an economic experiment supported by two stories and questions for comparison would be better for the ability of students (1) to identify and formulate the overarching concept that described the structural communality between the three sources, and (2) to recognize the endowment effect in transfer situations, than would be reading and comparing three stories.

Three findings emerged from the present study. First, an analysis of the student hand-ins showed that almost half of the students in the two research conditions were able to identify and describe the endowment effect or its effects on market outcomes, using their own terminology. Nevertheless, approximately thirty percent of the students in each of the two conditions described the overarching economic concept in merely neoclassical terms such as *prices are determined by supply and demand*. Second, ANCOVA and contrast analyses showed that students enrolled in the stories condition recognized the endowment effect significantly better in intermediate transfer task (the chimpanzee story) than students in the experiment condition. Finally, ANCOVA and contrast analyses pointed out that students enrolled in the experiment condition significantly outperformed students enrolled in the stories condition in recognizing the endowment effect in the far transfer task (the house for sale story). The next paragraphs elaborate what may have prompted these findings.

First of all, the finding that a substantial share of students described the overarching economic concept in neoclassical terms may be explained by the lack of behavioral economic concepts in the present curriculum. All students who participated in this study attended regular economics class hitherto. This may have triggered these students to come up with a standard economic concept in neoclassical terminology, as they probably did not expect to find a behavioral economic concept. Once behavioral economic concepts are addressed in the secondary school economics curriculum more frequently and students have become used to non-
neoclassical phenomena, they might get used to using behavioral economic terminology for describing their observations as well.

It remains not totally clear how the findings can be explained that students enrolled in the stories condition seemed to be better at the intermediate transfer task, whereas students enrolled in the experiment condition seemed to be better at the far transfer task. The results suggest that students in the stories condition seemed better in formulating their own descriptions of the endowment effect. This may have helped them in identifying the endowment effect more easily in situations that resembled the source stories with which they familiarized themselves. This suggestion seems in line with the idea that student performance on a transfer task can be improved by increasing the similarities between the learning and the transfer situation (e.g., Coetsier, Kok, & Kral, 2009; Vosniadou, 2007). Although students enrolled in the experiment condition scored worse at the intermediate transfer task than students in the stories condition, they outperformed their counterparts in the far transfer task. A possible clue may be found in the context of transfer (cf. Barnett & Ceci, 2002). Contexts of transfer regard from and to where something is transferred. They consider, amongst others, a physical, temporal, and social dimension. When looking at the contexts of transfer in the present study, students in the stories condition had to read a story and write down their answers during both the lesson and the transfer tasks. Hence, from the perspective of the students, the social context, functional context, and modality were similar during all activities. This equalized the learning situation and the transfer situation. Students in the experiment condition, on the other hand, had to switch from playing the experiment to reading stories. The learning tasks in the experiment condition thus required a transfer of social context, functional context, and modality even during learning. Perhaps this prepared the students in the experiment condition better for analyzing situations that deviated from the learning situation. Moreover, previous research has indicated that analogical reasoning might impose a high cognitive demand on the working memory of the students, especially when they have to divide attention between relevant
information for identifying the basic concept and unrelated texts (e.g., Richland & Hansen, 2013). The latter was the case in the far transfer task. Perhaps, the experiment condition has prepared students better for switching between contexts and for reducing cognitive demand during the transfer task. Future research should test this assertion.

Knowledge of the behavioral mechanisms underlying choice behavior might help students to employ responsible economic behavior in situations later on in life. From a curriculum perspective this requires both addressing essential behavioral economic concepts and finding appropriate ways to transfer these concepts across contexts, as students will undoubtedly encounter situations in future that differ from the situations they have met in economics class. Although previous studies have indicated that written stories and answering explicit compare-and-contrast-questions may be helpful for reaching transfer, the current study indicates that adding a behavioral economic experiment to reading two stories seems an even more promising approach towards the far transfer of a behavioral economic concept across contexts. Future research should elaborate this finding.
### APPENDIX

#### Box A.6.1 Three Stories in the Lesson

<table>
<thead>
<tr>
<th>Story 1: Coffee Mugs</th>
<th>Students at a university often volunteer as research participants. Forty-four students participated in a particular study. These students were assembled in an auditorium. Each student in half of the group (22 students in total) was given a coffee mug. These students were told the following: “Each of you now possesses a coffee mug. You have the opportunity to sell this mug if the price that will be announced later is acceptable to you. Please now indicate on the list for each price in dollars whether or not you are willing to sell the mug. If you do not sell the mug at any of these prices stated, you can take the mug home after class.” The other half of the group (22 students) was not given any coffee mug at all. These students were told the following: “None of you now possesses a coffee mug. But you have the opportunity to acquire one, if the price that will be announced later is acceptable to you. Please now indicate on the list for each price in dollars whether or not you are willing to pay for a mug.” In total, 44 students participated in this investigation. Buyers agreed to buy the mug for the prices they found acceptable, sellers agreed to sell the mug for the prices they found acceptable. Generally, students who initially did not possess a coffee mug were willing to pay $2.25 on average to acquire a mug. Students who initially possessed a coffee mug would like to receive on average $5.25 to sell a mug. The lowest price one of the sellers would accept was $2.25 for a coffee mug.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Story 2: Golf</td>
<td>Golf is a sport, played at a golf court. A golf player hits a little, hard ball with a golf club from the starting point in the direction of a little gap in the grass: The hole. The aim of this sport is to put the ball in the hole using as few strokes as possible. Each hole is classified by a number of strokes one might use to complete the hole. A golf player who uses this exact amount of strokes plays “par”. A golf player who uses one stroke less plays “birdie”. Usually, the last stroke is a “putt” – a short-distance shot to get the ball in the hole. Researchers investigated how well golf players played their last stroke. Data regarding millions of putts in golf matches indicate that golf players are less successful in putts when it considers a birdie as opposed to a par, although both strokes can be considered equally difficult.</td>
</tr>
<tr>
<td>Story 3: Basketball Tickets</td>
<td>Basketball is a very popular sport in the United States. Every year, people are eager to get the tickets that allow them to attend the games. Two investigators received contact details of the basketball supporters who sadly did not acquire the tickets they longed for. The researchers phoned these supporters and asked them: “We might have a basketball ticket for you. How much would you be willing to pay for it?” The investigators as well received contact details of the basketball supporters who actually managed to acquire the desired basketball tickets. The researchers phoned these supporters as well and asked them: “We might be interested in buying your basketball ticket. For how much would you be willing to sell it to me?” In total, over 100 supporters were phoned. On average, supporters who did not possess a ticket were willing to pay $175. Supporters who possessed a ticket were willing to sell their ticket for an average price of $2,400. Interestingly, none of the ticket-holding supporters was willing to accept a price that a non-ticket-holding supporter was willing to pay.</td>
</tr>
</tbody>
</table>

**Notes.** These three stories were inspired by, respectively, (1) experimental research on the endowment effect by Kahneman et al. (1990), (2) a risk-aversion study in golf by Pope and Schweizer (2011), and (3) an illustration of the high price of ownership by Ariely (2008). All stories were written for educational purposes in secondary education. They are therefore not intended to reflect the precise research procedures or results of the aforementioned studies. Students in the Stories condition read all three stories. Students in the Experiment condition participate in an experiment similar to the one described in story 1. Thereafter they read stories 2 and 3.
REFERENCES


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CHAPTER 7

DISCUSSION AND CONCLUSION

“A bat and a bal cost $1.10.
The bat costs one dollar more than the ball.
How much does the ball cost?”

(Kahneman, 2011, p. 44)
7.1 INTRODUCTION

Worldwide, economics teachers in secondary education aim at preparing their students for future learning and at guiding them towards economic literacy (e.g., Department for Education [DfE], 2014; Teulings, 2005). As described in Chapter 1, economic literacy refers to the ability of people to recognize and apply economic concepts in their own daily lives (Salemi, 2005). In the present thesis, economic literacy encompasses knowledge of economic concepts, the skill to set up economic reasoning, and the ability to transfer economic concepts across contexts. Previous research points out that people’s economic literacy is rather limited despite having attended economics class once (e.g., Walstad & Rebeck, 2002). This is why the current thesis explored how the economic literacy of students in secondary education may benefit from the use of economic experiments in class. As defined in Chapter 1, economic classroom experiments are controlled interactive teaching/learning activities that aim at fostering a student’s comprehension of economics in a bottom-up way. Although thirteen previous studies examined the educational value of economic classroom experiments, only one of these was executed in secondary education and none of these addressed explicitly the impact of economic classroom experiments on the broad concept of economic literacy.

Chapter 2 investigated the effects of economic classroom experiments on gaining knowledge of economic concepts. Chapter 3 examined how economic classroom experiments contributed to the ability of secondary school students to set up economic reasoning. Chapter 4 investigated the effect of economic classroom experiments on the ability of students to identify, formulate, and illustrate the economic concept of “equilibrium” through a process of analogical reasoning. Chapter 5 elaborated on the importance of a behavioral economic point of view on the content knowledge of secondary school economics when aiming at increasing the economic literacy of students. Following the latter perspective, Chapter 6 examined the use of a behavioral economic experiment when aiming at identifying and transferring a behavioral economic concept across contexts. The current chapter formulates general conclusions (section 7.2),
discusses recommendations for classroom practice and curriculum development (section 7.3), addresses the limitations of the present studies (section 7.4), and provides suggestions for further research (section 7.5).

7.2 SUMMARY OF THE MAIN FINDINGS

To investigate the question how economic classroom experiments can support the economic literacy of students, four empirical studies were set up and executed in secondary schools. In Chapter 2 of this thesis it was hypothesized that enrollment in an experiment participation condition \((n = 44)\) in which students interacted with each other in a series of economic classroom experiments would be more favorable for gaining knowledge of economic concepts than enrollment in less interactive research conditions in which students either observed peers engaged in economic classroom experiments \((n = 49)\), or attended standard lessons \((n = 41)\).

Following a pretest-posttest-control-group-design, knowledge tests were used to assess the students’ understanding of economic concepts. This was the first component of economic literacy as defined in this thesis. In line with the research hypothesis, students in the interactive experiment participation condition showed higher standardized knowledge gain scores than students who were enrolled in the other two conditions. The main finding of the first study is that interactions in and experiences from the actual participation in economic classroom experiments seemed to be favorable ingredients for gaining knowledge of economic concepts.

Chapter 3 explored how economic classroom experiments contributed to setting up economic reasoning, which was the second element of economic literacy in this thesis. Economic reasoning was defined as the ability to derive main variables from an economic context, to determine associations between those, and to formulate suitable explanations. The study was comprised of three research conditions. In the first, students participated in economic classroom experiments. In the second, students observed videos showing other students enrolled in economic classroom experiments. In the third, students analyzed experimental data.
To train their reasoning abilities, students were asked to formulate hypotheses, to test these, and to discuss their findings together during class. Previous research has shown that providing hypothesis generating tools or prefabricated testable hypotheses are a necessary support of (meta)cognitive learning processes (e.g., Gijlers & De Jong, 2009; Van Joolingen, 1999; Van Joolingen & De Jong, 1991; Van Joolingen & De Jong, 1997). Following this idea, in this study the reasoning process of the students was supported by a reasoning tool and a set of economic principles. Also ground rules for communication (e.g., Mercer, 1995) were provided to the students. These rules aimed at inducing exploratory talk, that is to say: Conversations in which students constructively discuss their findings together by exchanging and elaborating on each other’s arguments (e.g., Wegerif, 2001). Following a pretest-posttest-retention-test-control-group-design, the research hypothesis was investigated that experiment participation would be more beneficial for acquiring economic reasoning ability than would experiment observation or data analysis. Contrary to this hypothesis, the main finding of the second study is that students who participated in economic classroom experiments ($n = 36$) showed less reasoning ability than students who observed experiments from videos ($n = 27$) and students who analyzed data ($n = 45$). A possible explanation for this finding is provided by the observation that students who participated in economic classroom experiments hardly used economic principles during their reasoning in class. Such principles are considered important for explaining causal relationships (e.g., Eiriksdottir & Catrambone, 2011; Jonassen & Iona, 2008). As students in the two other research conditions used these principles more frequently during their economic reasoning in class, this might have resulted in better reasoning scores. A high demand placed on the short term memory of the students in the experiment participation condition may have prevented these students from using economic principles (cf. Kirschner, Sweller, & Clark, 2006). Although tools were provided to support the reasoning processes of the students in all three research conditions, students in the experiment participation condition also had to generate, record, and analyze data. The activities in the other two research conditions can be
considered less demanding for the students for these students did not have to generate data by themselves. Students who observed videos and students who analyzed data may have experienced less cognitive load on their short term memory.

The research in Chapter 4 took a closer look at the use of economic classroom experiments when aiming at supporting analogical reasoning along the economic concept of equilibrium. In a commodity market, an equilibrium refers to a situation in which the number of goods demanded equals the number of goods supplied (e.g., Schotter, 2003). This concept is present in secondary school economics curricula worldwide (e.g., Siegfried et al., 2010; Teulings et al., 2005). The focus of this study was to assess the ability of secondary school students to compare and contrast three situations (cf. Kneppers, 2007). These situations differed in surface characteristics but shared the overarching concept of equilibrium. Students used analogical reasoning to identify and generalize key elements from specific situations, formulate the overarching economic concept verbally, and illustrate this concept graphically. In this process, the students compared information from three cases (cf. Gick & Holyoak, 1983; Catrambone & Holyoak, 1989). These cases were taken from real life and considered, for example, the behavior of shoppers and vendors in a fruit market. Students in the experiment condition \((n = 43)\) participated in a microeconomic experiment first. From this experiment they could experience and observe how market equilibrium evolved from the demand and supply behavior of the participants. Hereafter, the students read two stories depicting the same concept of equilibrium in different contexts. When asked to reformulate specific terms from the three situations with which they were presented, students in the experiment condition came up with concrete terms such as “seller” or “buyer” significantly more often than students in the stories condition. The latter group did not participate in an economic classroom experiment but read three written stories instead \((n = 24)\). A main finding of the third study is that students in the stories condition seemed better in reformulating specific terms in a more abstract way, for example by using terms such as “supply” and “demand”. Students in the stories condition were
also significantly better at correctly formulating and drawing the overarching economic concept of equilibrium. Gaining concrete experiences during learning, as was the case in the experiment condition, might have resulted in formulating concrete terms, whereas the reading/writing activities in the stories condition may be associated with the use of more abstract terminology.

The empirical studies described in Chapters 2, 3, and 4 considered the economic concept market, which is a key concept in neoclassical economic theory. Central to neoclassical economics is homo economicus – a self-interested, fully rational human creature who reaches optimal economic decisions (Bruni & Sugden, 2007; Cartwright, 2011). Economics curricula in secondary school worldwide (e.g., DfE, 2014; Siegfried et al., 2010) seem based predominantly on a neoclassical approach. However, neoclassical economics lacks much of the real-world dimension of everyday life economic matters (see Chapter 5). This is why a strong focus on neoclassical economics might turn out to be a hindrance when aiming at increasing the economic literacy of students. Behavioral economics, on the other hand, incorporates insights from, amongst others, cognitive psychology (e.g., Cartwright, 2011; Sent, 2004) and addresses deviations from neoclassical theory that can be observed or applied in everyday life situations. This is why Chapter 5 advocated the addition of behavioral economic concepts to the secondary education economics curriculum and the exploration of subsequent effects of the use of behavioral economic experiments on the economic literacy of secondary school students.

Following this suggestion, the study described in Chapter 6 explored the use of a behavioral economic experiment to foster students’ understanding of a behavioral economic concept, as well as their ability to transfer this concept across contexts. Central in this study was the endowment effect, which illustrates that people attach more value to an object once they feel ownership over it (e.g., Kahneman, 2011; Thaler, 1980). This effect appears in many different ways and on a variety of occasions in everyday life situations (Chapter 6). Two research conditions were set up to explore how students could be supported in gaining knowledge of the behavioral economic endowment effect and in transferring this concept across
contexts. Students in the experiment condition \((n = 94)\) first participated in an experiment and then read two stories that illustrated the endowment effect. Students in the stories condition \((n = 128)\) read three stories regarding the endowment effect. Explicit questions helped students to compare the three situations. After this, all students were asked to recognize the endowment effect in two transfer situations. The main findings of the fourth study are that students in the stories condition significantly outperformed students in the experiment condition with regard to recognizing the endowment effect in an intermediate transfer task that resembled the situation the students met in class to a large degree, whereas students in the experiment condition were better at recognizing the endowment effect in a far transfer task that provided the students with distracting information. It was argued that a high level of similarity between the initial learning context and the transfer situation may have been beneficial for reaching intermediate transfer because individually reading stories and answering questions in the stories condition resembled the individual reading of stories and answering of questions during the transfer assessment. On the other hand, as far transfer regards more remote situations, a teaching/learning activity during initial learning that deviated from the transfer test seemed more favorable. This was the case in the experiment condition.

### 7.3 RECOMMENDATIONS

Over three decades ago, McCloskey (1983, p. 513) stated: “Economics is badly taught, not because its teachers are boring or stupid, but because they often do not recognize the tacitness of economic knowledge, and therefore teach by axiom and proof instead of by problem solving and practice”. The research described in this thesis investigated the merits and drawbacks of the use of economic classroom experiments as these may provide students with ways to experience and investigate economic matters from the bottom up and to increase their economic literacy. Given the findings described in section 7.2, the current section describes implications and recommendations for classroom practice and curriculum development.
The first recommendation is to carefully select the moment in the curriculum at which an economic classroom experiment is used. The current findings suggest that hands-on learning experiences gained by students in economic classroom experiments seem advantageous mainly for grasping basic economic concepts (Chapter 2; cf. Durham, McKinnon, & Schulman, 2007). However, active participation in these experiments seems detrimental for both setting up economic reasoning (Chapter 3), and for identifying, formulating, and illustrating abstract structural similarities between sources (Chapter 4). Following these results, it could be argued that participating in economic classroom experiments may be beneficial especially early in the learning process. A recommendation for the secondary school curriculum could be to let students participate in economic classroom experiments early in the curriculum when aiming at reaching student-understanding of basic economic concepts. This is in line with a recommendation formulated by Ebbers, Macha, Schlösser, and Schuhen (2012), who reached a similar conclusion regarding the role of economic classroom experiments within a university context.

A second recommendation is to record the data emerging from an experiment and re-use these at a later stage in the curriculum. When aiming at increasing the economic reasoning ability of students in secondary education, results indicate that the actual participation in a series of experiments seems needlessly demanding for the short term memory capacity of the students. However, teaching/learning activities that help students to formulate and test hypotheses by observing peers engaged in experiments or by analyzing experimental data seem more promising (Chapter 3). Once an economic classroom experiment has been played at an early stage in the curriculum to allow students to gain basic knowledge of economic concepts, the teacher could store the experimental data. At a later stage in the curriculum, students could re-use this dataset when practicing their economic reasoning skills. Following an approach similar to the one used in the data analysis condition (see section 3.3.3), students could use these data to test research hypotheses and formulate explanations and conclusions. From the viewpoint of
experiential learning, such an approach may further advance the so-called continuity of student experiences (cf. Dewey, 1938/1997): Experiences gained in the beginning of the curriculum will be used to elaborate on at a later point in time. Of course, the experiments used could also address other neoclassical economic concepts besides the topic market, such as cost-benefit analyses, or could include other behavioral economic concepts instead of the endowment effect, such as reciprocity or social preferences.

In pursuit of these suggestions, a third recommendation is to consider adding the behavioral economic perspective to the content of the national curriculum standards for secondary school economics. Economics teachers who aim at increasing the economic literacy of students have to provide their students with a set of glasses that enables them to observe, interpret, and reason along real world phenomena from an economic point of view (cf. Teulings et al., 2005). A set of economic principles that may be useful for doing so is proposed by Mankiw (2011; see also Box 3.1). However, the behavioral economic perspective is missing from the list by Mankiw. It could be argued that this exclusion may hinder students in becoming economically literate (cf. Chapter 5). A logical next step would be to enrich secondary school curricula in economics with a behavioral perspective. This suggestion is in line with recent recommendations by prominent economists and educators, who conclude that the content of the school subject of economics should become more realistic from a societal point of view (e.g., Van Dalen & Koedijk, 2012). Although national curriculum standards might not yet state the importance of insights emerging from behavioral economics explicitly (e.g., DfE, 2014; Siegfried et al, 2010), some teachers seem to have recognized an opportunity to bring behavioral approaches to the economics classroom.

A final recommendation could be to enhance textbooks for secondary school economics with an integrated set of (behavioral) economic classroom experiments and/or data sets, supporting tools, and exercises. An example may be illustrative here. In response to the observation that students find economic reasoning a hard job (Welp, Dieteren, & Kneppers,
2009), a well-thought series of reasoning exercises based on an experimental data set and supported by reasoning tools may help students to further enhance their economic reasoning skills, prepare them for this aspect in upcoming national examinations, and increase the reasoning aspect of their economic literacy within the boundaries as set by current economics curricula for secondary education. The addition of behavioral economic concepts and experiments may further strengthen students’ literacy from a more behavioral economic viewpoint. It must be said, though, that such an inclusion would imply stretching the boundaries of curricula for secondary school economics worldwide.

Taken together, to advance the economic literacy of secondary school students, the recommendations put forward in this section regard enriching economics curricula with a well-thought place for the various ways in which economic classroom experiments could be used to address both neoclassical and behavioral economic concepts.

7.4 LIMITATIONS

Although each of the studies described in this thesis have been carefully prepared and carried out, at least three weaknesses may put boundaries on the present findings. A first limitation is a possible lack of fidelity. Each of the interventions in the present thesis was designed at the level of the intended curriculum, that is to say: they reflect an ideal situation that is rooted in the literature. However, teaching/learning materials may have been re-interpreted by the teachers who worked with these materials in the classrooms. The latter reflects the level of the perceived curriculum (the interpretation of the materials by the teachers) and the operational curriculum (what teachers and students do with the materials in the classroom). A final stage at which one could take a look at the interventions is from the level of student experiences and student attainment, that is to say: How the students themselves perceived the educational materials and what their personal learning outcomes are. The importance of establishing the similarity between interventions-as-intended and interventions-as-implemented is stressed by,
for example, Nieveen (1999). Although the studies in the present thesis provided the teachers with personal training sessions (in which they learned how to use the teaching/learning materials) and measures were applied to capture classroom processes (e.g., the use of video cameras, audio recordings, and the collection of student materials), the fidelity of the interventions could have benefited from a more rigid implementation and monitoring regimen. The influence of an individual teacher on measurement outcomes could have been further restricted by increasing the level of details in the guidelines for instruction and debriefing in the teaching protocols or a more extensive application of process measures. The current research may as well have profited from increasing the number of participating teachers in the studies. Larger-scaled studies may not only decrease the influence of individual teachers on the implementation process and the learning outcomes of students, these may also help to increase representativeness and, as a result, the external validity of the outcomes. It must be said, though, that the comparability of experimental and control groups in the present studies was assured by post-hoc matching and statistical control (cf. Nieveen & Folmer, 2013). Moreover, the curricular levels of student experiences and student attainment in the present studies were monitored by means of, amongst others, initial motivation questionnaires, student self-reports, and posttests, all of which were aligned with the teaching/learning goals of the studies (cf. Nieveen, 1999).

Another admonition to be addressed is that the interventions described in this thesis were implemented and studied only once and that no further re-designs or re-implementations were executed and tested subsequently. The rationale of this procedure may be attributed to the general research question, which addressed the impact of economic classroom experiments on the broad concept of economic literacy: Knowledge of economic concepts, economic reasoning ability, and the transfer of economic concepts across contexts. Hence, although beyond the direct scope of the present research, the empirical studies lacked a recurring series of carefully designed educational design cycles. During such reiterative cycles of design and
implementation, teaching/learning materials and procedures could have been studied and improved (e.g., Collins, Joseph, & Bielaczyc, 2004; McKenney & Reeves, 2012).

A final caveat may be the emphasis of increasing economic literacy by means of economic classroom experiments in a formal educational setting. There may be three restrictions to this stance. First, the literature on economics education provides a number of inductive teaching/learning activities that may be considered as alternatives for economic classroom experiments, such as role-plays, simulations, and games. These alternative approaches may have increased a student’s understanding of economic concepts as well (e.g., Sutcliffe, 2011). Alternatives such as these were not studied and neither were their effects.

Second, formal educational programs aiming at increasing the awareness of students’ own economic literacy may come at the cost of inducing an overconfidence bias in students (Willis, 2008). This means that students who attended literacy education and face economic decisions later on in life can be “lured” into reaching unfavorable decisions, exactly because they, mistakenly, believe that their decisions are unbeatable (Lichtenstein, Fischhoff, & Phillips, 1982). On the other hand, not addressing economic literacy in class would be more or less a guarantee for this to happen.

Third, it can be argued that increasing the economic literacy of students may be even unnecessary for them to reach favorable economic decisions later on in life. For example, Thaler and Sunstein (2003) and Loewenstein and Haisley (2008) introduce the ideas of light paternalism and libertarian paternalism. The “paternalism” part of these concepts state that a carefully chosen default option in a particular choice situation will induce a desired behavior of consumers. The “light” respectively “libertarian” part of these concepts refers to the freedom consumers should feel to choose another option than the default. As both concepts enhance people’s decision-making without restricting it, they reflect the idea of nudging (Thaler & Sunstein, 2003; see also Passell, 2008). However promising nudging may appear, a sound dose of economic literacy may remain necessary to allow everyone to make educated choices,
as only economically literate people may be able to critically accept or reject the “nudged” default settings they face.

7.5 SUGGESTIONS FOR FURTHER RESEARCH

The studies presented in this thesis investigated the effects of the use of economic classroom experiments with secondary school students for gaining knowledge of economic concepts, developing the ability to set up economic reasoning, and building up the skill to transfer economic concepts across contexts. Although first directions towards the application and implementation of these experiments in secondary school curricula have been put forward throughout this thesis, future research is vital for refining the interventions and for corroborating the present findings.

As all interventions lacked a follow-up cycle during which the designs were refined and re-studied, a first direction for further research would be to perform educational design research cycles to examine aspects of each of the interventions presented in this thesis in-depth. As an example, a starting point of such a new research cycle could be to study what happens in class during the debriefing of the experiences gained by students who participated in an economic classroom experiment. It has been suggested that a structured reflection after experiment participation may be crucial for gaining economic literacy (e.g., Cartwright & Stepanova, 2012). However, as previous research in the context of geography education by Oost, De Vries, and Van der Schee (2011) indicates, secondary school teachers find debriefing the results of student experiences difficult. For instance, when debriefing inquiry learning activities, a considerable number of teachers indicates not to discuss in depth how freshly gained insights by their students relate to the theoretical notions of the discipline (Oost, De Vries, & Van der Schee, 2011). Findings such as these warrant the design of an extended protocol for the debriefing of student experiences gained in economic classroom experiments. Following an educational design research cycle, an advanced protocol for the debriefing of students’
experiences could be implemented and tested, and further improvements could be made and examined during a final research sequence.

Such a well-thought series of design research cycles would allow for the further refinement of virtually each of the elements that were present in the current four studies. These may regard, for example, the importance of observing other students (cf. Chapter 2), the function of ground rules for communication when students compare experimental outcomes with their preconceptions regarding relations between economic concepts (cf. Chapter 3), or the role of student dialogues in the process of comparing and contrasting sources during analogical reasoning (cf. Chapter 4). In turn, the results emerging from each of these cycles would contribute to a further understanding of the mechanisms by means of which aspects of economic literacy can be advanced when applying specific variants of economic experiments within the level of secondary education.

Future research could also test the effects of introducing economic classroom experiments in which students participate in an early stage of the curriculum and are asked to elaborate the experimental data at a later stage, as suggested in section 7.3. Following a stepped wedge design (cf. Brown & Lilford, 2006) the sequence of participating in experiments and setting up economic reasoning may be rolled-out to classes over a number of periods. In the end, all groups of students will have gone through the complete set of teaching/learning activities, although the order in which they did so was determined beforehand at a random basis. This would allow for modeling the effect of time and for testing sequential effects of the educational intervention proposed.

Another direction for future research could be to study aspects of economic classroom experiments with regard to student motivation. As can be read from the findings presented in the final column of Table 1.1, six of the previous studies on the educational use of economic classroom experiments measured student motivation. Often, these did so “on the side” without formulating a proper theoretical basis for doing so. Although three of these studies (Dufwenberg
& Swarthout, 2009; Durham, McKinnon, & Schulman, 2007; Mitchell, 2008) do not find any positive effect of participation in economic classroom experiments on the motivation of students, three other studies (Cebula & Toma, 2002; Haus, 2009; Yandell, 1999) report positive effects. As an example, an analysis of the student self-reports used by Haus (2009) indicates that the participation of students in economic classroom experiments seems favorable for their motivation and their interest in microeconomics. According to Ryan and Deci (2000), people are intrinsically motivated by nature, but supportive conditions are required to maintain and enhance this motivation. Students taught in environments that support autonomy (experiencing some degrees of freedom and choice when performing teaching/learning activities), competence (feeling capable of mastering particular knowledge and skills), and relatedness (being interactive and feeling connected to other people) show more interest and enjoyment and learn more effectively than students enrolled in strongly externally regulated learning situations (Deci & Vansteenkiste, 2004; Krapp, 2005). Moreover, in the related sub domain of financial literacy research, results from the PISA-survey show a positive association between students’ attitudes towards learning and their financial literacy (Organisation for Economic Co-Operation and Development [OECD], 2014). Findings such as these encourage the idea that studying motivational aspects of student enrollment in economic classroom experiments should be considered. This may be achieved by including motivation questionnaires in future empirical research in a systematic way. Validated and standardized tests, such as the Intrinsic Motivation Inventory (Ryan & Deci, 2011) may turn out to be useful means when aiming at doing so.

Further research could also study aspects of the interventions within a laboratory setting instead of in real-life classrooms. In the empirical studies described in this thesis, all data were collected using students and their teachers in common classroom settings. This approach can be advantageous from the viewpoint of ecological validity, which states that the setting, methods, and materials of the studies should resemble the real-world practice that is under investigation (e.g., McKenney & Reeves, 2012). Moreover, this approach may also benefit the
external validity of the findings, which refers to the generalizability of the findings to other circumstances with other partakers (e.g., Fraenkel, Wallen, & Hyun, 2012; Santos, 2011). Nevertheless, future studies regarding learning from economic classroom experiments could consider bringing randomized individual students into laboratory situations (cf. Gick & Holyoak, 1983; Gick, 1985). This would allow for controlling research circumstances more extensively and may further increase the internal validity of the research.

Future studies may also corroborate the present results. On the one hand, large-scaled replication research in Dutch secondary schools could provide additional support for the present findings and may further reduce the influence of individual teachers (e.g., work experience) on the research outcomes. Small-scaled studies in secondary school contexts outside the Netherlands, on the other hand, could provide insights regarding possible cultural effects of the experimental interventions. The latter may be relevant as research shows that cultural differences may influence how people behave in economic experiments (e.g., Henrich et al., 2005). For instance, the meta-analysis by Oosterbeek, Sloof, and Van de Kuilen (2004) indicates that the behavior of responders in ultimatum games (e.g., section 5.2) differs across regions. They find, amongst others, that Asian responders tend to reject offers more frequently than responders from North America. As economic classroom experiments are derivatives of experiments used in economics research (e.g., Chapter 1), a cross-cultural comparison of educational effects may assure the reliability and validity of the present findings in educational contexts worldwide.

A final direction for further research is studying the retention of economic literacy. The posttests applied in the present studies regarded a direct posttest (Chapters 2, 4 and 6) and a 6-weeks-delayed posttest (Chapter 3). Measuring the retention of specific aspects of economic literacy means studying far transfer at a temporal dimension, e.g., years from now (cf. Barnett & Ceci, 2002). This implies a more longitudinal research design for which, for example, a cohort study could be used. Such an approach follows groups of students throughout their life...
span and compares their subsequent performance on all relevant aspects of economic literacy (cf. Centre for Longitudinal Studies [CLS], 2015). However, such an expensive, longitudinal study is sensible only if the robustness of specific interventions on the economic literacy of students has been established thoroughly.\textsuperscript{39}

This thesis investigated how economic classroom experiments may be used to increase the economic literacy of secondary school students. The findings suggest that participating in economic classroom experiments may serve the economic literacy of these students mainly during the introduction of economic concepts. The economic reasoning ability of students may benefit most likely from analyzing experimental data with which the students are provided. Furthermore, indications are found that participation in a behavioral economic experiment that is combined with reading and comparing written stories seems to foster far transfer. As pointed out in the current chapter, though, further educational design research cycles are necessary to improve each of the interventions employed and to corroborate the present findings.
REFERENCES


SUMMARY (IN DUTCH)

Dit proefschrift is een verhandeling over de bijdrage die economische klaslokaalexperimenten kunnen leveren aan de economische geletterdheid van leerlingen in het voortgezet onderwijs. Economische geletterdheid betreft de mate waarin mensen in staat zijn om economische concepten te herkennen en te gebruiken in hun dagelijks leven (Salemi, 2005). Mensen blijken maar matig economisch geletterd te zijn, zelfs als zij ooit economisch onderwijs genoten hebben (Hansen, Salemi, & Siegfried, 2002; Walstad & Rebeck, 2002). In dit proefschrift wordt economische geletterdheid uiteengerafeld in drie elementen: kennis van economische concepten, economische redeneerbaarheid en het vermogen om kennis te transfereren tussen contexten. Elk empirisch hoofdstuk in dit proefschrift bespreekt één van deze deelaspecten, teneinde de vraag te kunnen beantwoorden hoe economische klaslokaalexperimenten de economische geletterdheid van leerlingen in het voortgezet onderwijs mogelijkwijs kunnen verbeteren.

Lang is verondersteld dat laboratoriumexperimenten zouden zijn voorbehouden aan natuurwetenschappers (Friedman, 1966; Samuelson & Nordhaus, 1985). Economen voeren echter al een kleine eeuw experimenten uit om economische verschijnselen te bestuderen (bijvoorbeeld Thurstone, 1931; Chamberlin, 1948; zie ook Svoreněk, 2015). Zij creëren daartoe vaak een laboratoriumomgeving waarin het gedrag van proefpersonen kan worden gecontroleerd, gemanipuleerd en geobserveerd (Fiore, 2009). De afgelopen decennia is een indrukwekkende hoeveelheid publicaties verschenen die betrekking heeft op zowel de methodologie van economische experimenten (bijvoorbeeld Guala, 2005; Smith, 1976) als de consequenties die experimentele bevindingen kunnen hebben voor economische theorie (zie bijvoorbeeld Ball, 1998; Croson & Gächter, 2010). Het in 2002 toekennen van The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (ookwel de Nobelprijs voor Economie genoemd) aan Vernon Smith kan worden beschouwd als een brede erkenning van
het belang van experimenten voor de economische wetenschap (Royal Swedish Academy of Sciences [RSAS], 2002).


Er zijn dertien studies bekend die in het verleden de invloed van economische klaslokaalexperimenten op aspecten van economische geletterdheid empirisch hebben onderzocht. Op de studie van Haus (2009) na, waren al deze onderzoeken echter gericht op universitaire studenten. Met andere woorden: er is nog weinig bekend over het leren van
leerlingen die deelnemen aan economische klaslokaalexperimenten in het voortgezet onderwijs. Ook lijken eerdere empirische studies zich vooral op kennis van economische concepten en enigszins op redeneervaardigheid te hebben gericht, terwijl economische geletterdheid daarnaast ook aandacht voor transfervaardigheden vereist (zie Hoofdstuk 1).

In hoofdstuk 2 van dit proefschrift staan de effecten van economische klaslokaalexperimenten op de kennisontwikkeling van leerlingen ten aanzien van economische concepten centraal. De studie die in dit hoofdstuk wordt beschreven, vergelijkt de prestaties van leerlingen in drie onderzoekscondities met elkaar. In de eerste conditie participeren leerlingen ($n = 44$) in een serie van vier economische klaslokaalexperimenten. In de tweede conditie observeren leerlingen ($n = 49$) vier video’s waarin peers te zien zijn die in economische klaslokaalexperimenten participeren. In de derde onderzoeksconditie volgen de leerlingen ($n = 41$) vier reguliere lessen. Kennis van economische concepten is gemeten tijdens een voormeting en een nameting, op basis waarvan een gestandaardiseerde kennisontwikkeling aangaande economische concepten bij de leerlingen is berekend. Leerlingen die participeerden in economische klaslokaalexperimenten laten een significant grotere kennisgroei zien dan leerlingen in de twee andere onderzoekscondities. Het interactief participeren in economische klaslokaalexperimenten lijkt dan ook bevorderlijk te zijn voor het opdoen van kennis van economische concepten.

Hoofdstuk 3 onderzoekt de invloed van economische klaslokaalexperimenten op de verwerving van economische redeneervaardigheid van leerlingen. Deze vaardigheid wordt gedefinieerd als het kunnen identificeren van belangrijke variabelen in een economische context, het bepalen van een verband tussen deze variabelen en het geven van een verklaring voor het verloop van dit verband. De redeneervaardigheid van leerlingen wordt op drie momenten in de tijd gemeten via een nulmeting, een eindmeting en een zes weken uitgestelde retentiemeting. Evenals de vorige studie vergelijkt ook deze studie de prestaties van leerlingen in drie onderzoekscondities met elkaar. In de eerste conditie participeren leerlingen ($n = 36$) in
ondermeer van belang om de congnitieve belasting van leerlingen die participeren in een experiment en waarin de lesdoelen zijn gericht op economisch redeneren te reduceren.

In Hoofdstuk 4 wordt bekeken hoe economische klaslokaalexperimenten kunnen bijdragen aan analoog redeneren. Hieronder wordt het proces verstaan waarin leerlingen leren om een concept dat zij tegenkomen in de ene situatie, te herkennen in een nieuwe situatie die daarop lijkt (Gick & Holyoak, 1983; Salomon & Perkins, 1989). Het centrale concept in deze studie is *marktevenwicht*, wat verwijst naar de situatie waarin vraag en aanbod aan elkaar gelijk zijn (Schotter, 2003). In navolging van de suggestie van Kneppers (2007) richt deze studie zich op niet zozeer op de vraag of leerlingen bepaalde kennis kunnen herkennen of toepassen in een nieuwe context, wat een *direct application*-benadering genoemd zou kunnen worden (vergelijk Bransford & Schwarz, 1999). In plaats daarvan wordt de mate onderzocht waarin leerlingen in staat zijn om verschillende situaties met elkaar te vergelijken. De bedoeling van dit proces van analoog redeneren in deze studie is dat leerlingen concrete informatie die zij in verschillende situaties tegenkomen leren vertalen naar meer algemeen geldende abstracties. De vaardigheid van abstraheren wordt door meerdere onderzoekers van belang geacht voor het komen tot transfer (bijvoorbeeld Salomon & Perkins, 1989). Om leerlingen hierbij te ondersteunen maakt de studie in Hoofdstuk 4 gebruik van expliciete vragen en een visualiseringsopdracht. Deze helpen de leerlingen in hun zoektocht naar overeenkomsten en verschillen in de drie situaties waarmee zij geconfronteerd worden. De ondersteuningsvragen richtten zich op het herformuleren van begrippen, het formuleren van een overkoepelend economisch concept en het tekenen van dit centrale concept (zie ook Box 4.1). Leerlingen in de experimentconditie (*n* = 43) participeerden eerst in een economisch klaslokaalexperiment, waarna zij twee verhalen te lezen kregen. Alle drie deze situaties verschillen qua oppervlaktekenmerken, want ze betroffen diverse contexten (een fruitmarkt, een wildpark en een kinderdagverblijf). De drie situaties kenden echter het concept *evenwicht* als een gemeenschappelijke onderliggende structuur. Leerlingen in de verhalenconditie (*n* = 24) participeerden niet in een experiment maar

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lazen ieder drie verhalen. De resultaten laten zien dat leerlingen die participeerden in een economisch klaslokaalexperiment vaker met concrete herformuleringen van elementen binnen de situaties kwamen, terwijl leerlingen in de verhalenconditie tot abstractere formuleringen kwamen. Dit wordt mogelijk veroorzaakt doordat leerlingen die deelnamen aan een experiment concrete ervaringen opdenen. Leerlingen in de verhalenconditie bleken daarnaast beter in staat om het onderliggende concept *evenwicht* te identificeren, zowel in het schriftelijk formuleren als in het grafisch weergeven ervan. Deze bevindingen lijken waardevol gezien de constatering uit eerder onderzoek naar het belang van abstractievermogen voor transfer.

In Hoofdstuk 5 wordt beargumenteerd dat de studies in de hoofdstukken 2 tot en met 4 met name neoklassieke economische inhouden bespraken, terwijl de opkomende gedragseconomische benadering van de economie minstens zo belangrijk zou kunnen zijn voor de economische geletterdheid van leerlingen. Gedragseconomen gebruiken inzichten uit bijvoorbeeld de cognitieve en de sociale psychologie, alsmede experimenten om het economisch gedrag van mensen te bestuderen, te verklaren en, uiteindelijk, te modelleren (bijvoorbeeld Cartwright, 2011; Sent, 2004). Door het vergroten van de realiteitswaarde van economisch gedrag, kan de gedragseconomie bijdragen aan de betekenis die economie heeft voor het dagelijks leven (Hoofdstuk 5). Dat in 2002 óók aan Daniel Kahneman *The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel* werd toegekend, kan worden beschouwd als een brede erkenning van het belang van gedragseconomie, naast het eerder besproken belang van de experimentele economie (RSAS, 2002).

In het verlengde hiervan bespreekt Hoofdstuk 6 de bijdragen die economische klaslokaalexperimenten kunnen leveren aan de transfer van een gedragseconomisch concept, namelijk het *endowment effect*. Het endowment effect illustreert dat mensen meer waarde hechten aan voorwerpen zodra ze zich daar eigenaar van voelen (Thaler, 1980; zie ook Kahneman, Knetsch, & Thaler, 1990). Dit effect doet zich voor in een groot aantal situaties in het dagelijks leven (Hoofdstuk 6). Door leerlingen verschillende situaties voor te leggen is in
deze studie bekeken of zij in staat waren het endowment effect als zodanig te identificeren en of zij dit effect konden herkennen in transfersituaties. Deze studie kende twee onderzoekscondities. Leerlingen in de experimentconditie \((n = 94)\) participeerden eerst in een gedragseconomisch experiment. Daarna lazen zij twee verhalen. Deze drie situaties verschilden qua oppervlaktekenmerken, want ze betroffen uiteenlopende contexten, te weten koffiemokken, een golfbaan en toegangskaartjes voor een basketballwedstrijd. De drie situaties kenden echter het endowment effect als gemeenschappelijk onderliggend concept. Leerlingen in de verhalenconditie \((n = 128)\) participeerden niet in een experiment, maar lazen ieder drie verhalen. Uit de transfertoets bleek dat leerlingen in de experimentconditie beter waren in het herkennen van het endowment effect in een context die erg afweek van de leersituatie (de zogenoemde verre transfer), terwijl leerlingen in de verhalenconditie dit effect beter herkenden in een context die wat meer leek op de leersituatie (de zogenoemde intermediate transfer).

Tenslotte bediscussieert Hoofdstuk 7 alle bevindingen en worden de consequenties hiervan voor vervolgonderzoek verkend. Ook worden aanbevelingen geformuleerd in de richting van inhouden en vormgeving van het toekomstige economieonderwijs. Deze aanbevelingen betreffen ondermeer op welk moment en in welke vorm economische klaslokaalexperimenten in het economiecurriculum het best tot hun recht zouden kunnen komen. De bevindingen in Hoofdstuk 2 van dit proefschrift suggereren, overigens in lijn met Ebbers, Macha, Schlösser en Schuhen (2012), dat participatie in economische klaslokaalexperimenten met name behulpzaam lijkt voor het kennismaken met economische concepten. Dat zou ervoor pleiten om deze experimenten vóórwaan in het curriculum op te nemen. De docent zou de experimentele data die voortkomen uit deze experimenten kunnen bewaren, om ze op een later moment in het curriculum aan te kunnen wenden als bronnenmateriaal voor het trainen van de economische redeneervardigheid van leerlingen. Deze aanpak vloeit voort uit de bevindingen die beschreven staan in Hoofdstuk 3. Een andere aanbeveling die de economische geletterdheid van leerlingen zou kunnen bevorderen komt
voort uit de bevindingen die zijn beschreven in Hoofdstuk 5 en 6, namelijk het toevoegen van gedragseconomische inzichten aan het economiecurriculum op middelbare scholen. Hierdoor zouden situaties waarin individueel keuzegedrag gerelateerd wordt aan real-life psychologische factoren en omstandigheden op een nog realistischer wijze het klaslokaal kunnen worden binnengebracht. Het onderzoek in Hoofdstuk 6 geeft voorzichtig aan dat participatie in gedragseconomische experimenten bevorderlijk zou kunnen zijn voor de verre transfer van economische concepten, en daarmee voor economische geletterdheid van leerlingen.

Er blijft evenwel ook nog veel te ontdekken en bij te stellen, bijvoorbeeld ten aanzien van de nabespreking van economische klaslokaalexperimenten (vergelijk Oost, De Vries, & Van der Schee, 2011). Nader onderzoek gericht op het verfijnen van onderdelen van de huidige interventies via zogenoemde educational design research cycles, alsmede het repliceren van de huidige studies op een grotere schaal danwel in andere contexten lijken hierbij van belang. Het onderhavige proefschrift heeft evenwel al een belangrijke eerste exploratie uitgevoerd naar de bijdrage die het gebruik van economische klaslokaalexperimenten kan leveren aan de economische geletterdheid van leerlingen in het voortgezet onderwijs.
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CURRICULUM VITAE (IN DUTCH)


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Endowment effect 163, 189-194, 196-197, 200-211, 213, 229-230, 232.


2 The community reinvestment act encouraged financial institutions to meet the demand for credit of all neighborhoods in which they operated, including those featuring low and moderate incomes. See also http://www.federalreserve.gov/communitydev/cra_about.htm.

3 *Bundesland* is the German equivalent of a federal state in the United States. Education is organized within each individual Bundesland. Hence, no “national curriculum” exists for the school subject of economics at the level of secondary education.

4 Indifference curves are microeconomic graphs that show combinations of bundles of goods between which someone is indifferent (e.g., Schotter, 2003). As an example, a person’s utility of acquiring 1 apple and 2 bananas may be equal to her utility of acquiring 2 apples and 1 banana. Needless to say that acquiring 2 apples and 4 bananas may yield an higher level of utility. The latter bundle of fruits, however, could be likely as satisfying for her as would be the acquisition of 4 apples and 2 bananas.

5 Opportunity costs can be defined in this case as the loss of an specific income once another way of earning money has been chosen. Hence, rewards that, at least, equal opportunity costs in an experiment may imply that the average payment for participating in a one-hour experiment equals the hourly wage a participant would gain normally.

6 Many of the rules governing economic experiments originate from experimental psychology (e.g., Friedman & Cassar, 2004; Tammi, 2003). However, as the aims of economic experiments differ from those employed in psychology, so do the rules. Elaborating these differences, Hertwig and Ortmann (2001) identify experimental economists to make use of scripts, repeated trials, and performance-dependent and salient monetary payments, whereas experimental psychologists generally prefer the use of open-ended experiments, one-shot-deals, and no or fixed monetary payments.

7 Of course, the same is true for carefully designed experiments in other scientific disciplines.

8 A small discussion on the side seems inevitable here. One way to overcome the problem of a possible low external validity in economic laboratory experiments might be to use economic field experiments instead. In a field experiment, subjects are observed in (manipulated) everyday life settings. Hence, the “participants” may be even unconscious that they are part of any research at all (Harrison & List, 2003; Harrison & List, 2004; Levitt & List, 2009; Nikiforakis, 2010). However, field experiments may cause methodological concerns as well. For example, the complexity of the real world in concordance with our own limited possibilities to observe and record what takes place in a specific setting may cause interpreting problems. Although laboratory experiments in economics may suffer from a lack of external validity, economic field experiments may suffer from a lack of internal validity (e.g., Heukelom, 2009; Smith, 1989). Perhaps, future research will point out that both types could be considered complementary tools (e.g., Nikiforakis, 2010). The use of field experiments may become especially important given the recent development of economics towards a more behavioral science, as will be further elaborated in
Chapters 5 and 6 of this thesis. It has been argued that the generalizability of findings from the laboratory “is an exaggerated concern among non-experimenters” (Camerer, 2011, p. 46), amongst others as most experiments are merely designed to test economic theory instead of aiming at generalizing laboratory findings to the field (Camerer, 2011). Moreover, Camerer (2011) indicates that a considerable share of laboratory experiments that are designed to test lab-field generalizability show that experimental findings can be generalized to the field.

Nevertheless, it has been argued that a little, randomly assigned, salient monetary reward can be useful (Holt, 1999).

The value and use of authentic contexts will be elaborated on in Chapters 5 and 6.

The abbreviation JEL refers to the *Journal of Economic Literature*. The codes used in the JEL-classification system have become a widely accepted method of organizing scientific publications in economics. As an example, in this system *A21* refers to *Economics Education and the Teaching of Pre-College Economics*. Further information regarding the JEL-codings can be obtained through the website of the American Economic Association: [https://www.aeaweb.org/jel/guide/jel.php](https://www.aeaweb.org/jel/guide/jel.php).

In the Netherlands, these educational levels are known as ‘3 havo/vwo’.

The final labels are depicted in Table 2.5.

In the Netherlands, this educational level is known as ‘3 havo’.

The audio recordings indicated that teachers adhered to these instructions and the protocols.

“I won’t see it till you get it” is a translation of the original Dutch sentence “Je gaat het pas zien als je het doorhebt” by Johan Cruyff.

The radiation problem was based on the publication by Duncker (1945).

In the Netherlands, this educational level is known as ‘3 havo’.

The distinction between surface and deep characteristics in the stories used in the present study is mainly defined in terms of semiotic criteria. As an example: a pencil and a pen may vary in surface characteristics, such as shape, color, composition, or weight. These objects, however, seem quite similar with respect to their deeper structure or their higher order relations (cf. Chi & Van Lehn, 2012), as both of these can be used to write sentences and draw lines on a sheet of paper.

Sen (1977) introduced the term “rational fool” when illustrating the downsides and limitations incurred by the neoclassic economic assumption of self-interested rationality.

Institutional economics stresses the importance of studying the role of institutions. For example, markets are perceived as a result of complex interactions of a wide array of interrelated institutions, such as consumers, producers, governments, banking systems, laws, or social customs (e.g., North, 1990; Rutherford, 1994).

Evolutionary economics studies all kinds of processes that influence the economy from the inside. For example, producers may learn from their past experiences, which may affect their interactions with other economic agents, and reshapes economic outcomes (e.g., Nelson & Winter, 1982).
This implies as well that the traditional epistemology of generalized characterizations in economics is annexated gradually by an upcoming epistemology of verification and falsification (Heukelom, 2014).

Overviews can, amongst others, be found in popular literature such as Ariely (2008), Ariely (2012), Kahneman (2011), and Schwartz (2004).

As an example, it can be argued that students who understand the effects of a decoy option and the relativity of choices as have been studied by, amongst others, Ariely (2008) and Huber, Payne, and Puto (1982) may think twice before ordering the large coffee as offered in the canteens during lunch next to relatively expensive small- or medium-sized cups.

In other situations, the endowment effect is merely observed by the price someone is willing to pay (WTP) for obtaining an object owned by someone else. This price is often smaller than the price she wants to accept (WTA) for selling the same object when she herself would have owned it (e.g., Kahneman, Knetsch, & Thaler, 1990).

Tversky died June 2nd, 1996 and this prize is not granted posthumously. The other winner of this prize in 2002 was Vernon Smith for his research on experimental economics. Further details can be obtained via RSAS (2002).

Only since a decade or so, insights from the field of behavioral economics seem to have appeared in formal textbooks to undergraduate students (e.g., Altman, 2007; Camerer, Loewenstein, & Rabin, 2004; Cartwright, 2011; Diamond & Vartiainen, 2007; Wilkinson, & Klaes, 2011).

In the Netherlands, this educational level is known as ‘4 havo’.

Only the students in the experiment condition participated in an experiment, the students in the stories condition read a story illustrating this experiment.

It should be acknowledged, though, that the expert formulations of the endowment effect by Thaler (1980), Kahneman, Knetsch, and Thaler (1990), and Kahneman (2011) are more advanced.

This “simple” puzzle has been brought forward by Kahneman (2011). The intuitive answer is $0.10. Kahneman (2011) reports that over half of the students at renowned universities (e.g., Harvard) came up with this intuitive but wrong answer. At other universities, the percentage of incorrect answers was even 80%. The reason why the majority of people reaches the incorrect answer is that most of them seem overconfident in their intuition. This makes them to stop reasoning logically when confronted with such an “easy” mathematical problem. Their intuition takes over, which results in an unprofitable answer. Parenthetically, the correct answer is $0.05. A short calculation may clarify this: if a ball costs $0.05 then a bat costs $0.05 (the price of the ball) + $1.00 (the amount of money the price of the bat exceeds the price of the ball) = $1.05. In sum, $0.05 (for the bal) and $1.05 (for the bat) add up to a total of $1.10.

As an example, during a Dutch conference on teaching economics (Landelijke Werkgroep Economie Onderwijs [LWEO], 2014), a new educational syllabus was presented. These extracurricular materials (see http://lweo.nl/leerling/456vwo/gedragseconomie/) introduce pre-university students to behavioral economic theories. This initiative may turn out to be a first step to enriching the knowledge content of
In a role-play, students actively act out a role and communicate with others while being a character in a specific situation and setting. Afterwards, a classroom discussion takes place to review the activity (Alden, 1999; Feinstein, Mann, & Corsun, 2002; Lombardi, 2007; Oberhofer, 1999; Sutcliffe, 2011). In a simulation, students work, alone or together, in a (virtual) representation of a real-world environment, in which they make decisions and reflect on their actions, in order to deepen their understanding of economic concepts (Sutcliffe, 2011). A game is a special form of a simulation. It is competitive and strategic in nature because it includes specific rules that allow students to win or lose, for example by stating a goal (e.g., maximizing one’s own profits), setting a timeframe within which a student should finish the game, and indicate which actions are allowed, and which are not (Feinstein, Mann, & Corsun, 2002; Galarneau, 2005; Sutcliffe, 2011). All these activities start in a (virtual) situation, in which students have the opportunity to reach a decision and/or to interact.

Moreover, it may be impossible to arm students with all the knowledge and skills to become economically literate for the rest of their lives during a relatively few hours of initial formal education, while people who “invent” financial products can come up with new and sneaky fine prints in contracts and luring but untrustworthy advertisements on a daily basis (e.g., Kahneman, 2011; Willis, 2008). As a possible answer to this threat, the importance of implementing educational programs throughout people’s lifespan could be stressed. This is in line with the concept of lifelong learning. Of course, because people develop their capacities during their lives in heterogeneous ways, these educational programs may have to be adapted to different target groups, as Lusardi and Mitchell (2007) suggest.

A recent study exemplifies how nudging may guide people in reaching economic decisions. In 2008, a Dutch government website through which students could apply for a study loan showed the maximum loan possibility as the default option to all site visitors. This default setting was modified in 2010 in such a way that students who wished to apply for the maximum amount had to actively change the default amount. As a result, the percentage of students who applied for a maximum loan dropped from 68% in 2008 to 11% in 2010 (Van der Steeg, 2015).

It could be valuable to let teacher-students participate in research projects that address specific steps of these design research cycles. Such an approach would allow for the improvement of relevant aspects of economic classroom experiments, meanwhile providing a meaningful context for teacher-students to practice their research skills as stipulated by the curriculum of their teacher training institutes (see, for example: HAN, 2014a; HAN, 2014b; HAN, 2014c). Moreover, such an approach could also be an opportunity to gather a considerable amount of data in a variety of schools for secondary education within a limited time frame.
To allow researchers to use exactly the same sets of research instruments and educational materials that have been applied in the present studies, selecting schools for secondary education in the Dutch-speaking communities in Belgium (Flanders) or Aruba could be considered. Alternatively, when future research contexts would be non-Dutch speaking, a procedure of forward/backward translation (e.g., WHO, 2015) could be applied to convert and validate instruments and materials into the applicable target language.

At the core of this far transfer at the temporal dimension is the ability to solve new problems in a wide array of contexts by relating these to earlier situations (Holyoak, Junn, & Billman, 1984). As both stories and experiments used in the present research (e.g., Chapters 4 and 6) merely model certain aspects of real life, the question comes to mind whether reading transfer problems stated in written stories or even participating in classroom experiments would prepare students best for applying responsible economic behavior in the real world. In line with this idea, Day and Goldstone (2012) suggest the use of real world settings during learning and transfer situations. In the context of economics education, the latter may be achieved by applying field experiments (cf. Ariely, 2008). In a field experiment, subjects are observed in manipulated everyday life settings. As stated before, the participants may even be unconscious that they are part of any research at all (Harrison & List, 2003; Harrison & List, 2004; Levitt & List, 2009; Nikiforakis, 2010). Inspired by Blavatskyy and Pogrebna (2010), to investigate the occurrence of the endowment effect by means of a field experiment, one could think of organizing a variant of the famous Endemol television show “Deal or No Deal” in which students act as contestants after school. This game is organized around a main contestant who has to open a series of envelopes, which all contain a certain value. The values that exist in the game are known beforehand. However, the exact value in each individual envelope is kept as a secret to everyone. The game starts with the main contestant choosing an envelope, which is hers to keep. This envelope remains unopened until the end of the game. Next, the contestant has to choose another envelope from the 25 remaining ones. The value inside this envelope will be publicly announced immediately, and will be removed from the game. On a regular basis, the main contestant will be offered a value for quitting the game. These offers are based on the values that are still present in the game. It must be stated, though, that these offers are generally lower than the expected value based on actual calculations of probability. In response, the main contestant can accept (“Deal!”) or reject (“No deal”) this offer. If a deal has been reached, the contestant accepts the offer and the game ends. If no deal has been reached, the game continues as described before. It could be argued that the endowment effect and loss aversion are present in this show as well. Hence, the observations of the behavior of the main contestant in this show can be used either as a starting point for discussing the endowment effect in class or for assessing the extent to which students are aware of the endowment effect after having gained knowledge of this effect in class. Alternatively, one could also study a student’s actual economic behavior in other settings taken from everyday life, for example during a telephone interview (e.g., Fong, Krantz, & Nisbett, 1986). Future research could also compare the
effects of multiple combinations of such teaching/learning activities and assessment tasks on the economic literacy of students.