

## THE INFLUENCE OF A TIMED BROWSER (\*TB) INTO WEB-BASED INSTRUCTION ON COMPUTER SCIENCE STUDENTS' MOTIVATION TO LEARN PROGRAMMING LANGUAGES: PRELIMINARY FINDINGS

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**ABSTRACT.** This article presents the preliminary findings of research which aimed to explore the influence of a Timed Browser (\*TB) as an innovative pedagogy on computer science students' motivation to learn programming language. The rapid development of web-based instruction enhances the need of teachers and curricula developers to investigate the individual learner's characteristics and needs, the interaction within teaching systems, and the new role of the instructor, website developer, and the student within the learning process. First, a literature review will provide the theoretical foundation, and then the quantitative methodology used in stage 1 of the research will be presented. Finally, the findings that emerged from the first stage of research on a PhD level will be presented and discussed.

**Key words:** *web-based instruction, timed browser (\*TB), computer science, programming language, motivation to learn.*

**ABSTRAKT.** Dieser Artikel präsentiert die einleitenden Forschungsergebnisse, die darauf abzielten, den Einfluss eines Timed Browser's (zeitlich festgelegter Browser) (\*TB) als ein innovatives pädagogisches Instrument für die Motivation von Computerwissenschaftsstudenten beim Lernen einer Programmiersprache zu untersuchen. Die rasche Entwicklung Web-basierender Anweisungen vergrößert den Bedarf an Lehrern und Lehrplanentwicklern, um die individuellen Charakteristika und Bedürfnisse des Lernenden, die Interaktion mit den Lehrsystemen und die neue Rolle des Ausbilders, Webseitenentwicklers sowie des Studenten im Lernprozess zu erforschen. Zuerst soll eine Literaturrezension die theoretische Grundlage bilden, sodann wird eine quantitative Methodologie

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präsentiert, die in Stufe 1 der Untersuchung verwendet wird. Abschließend werden die aus der ersten Stufe der Untersuchung gewonnenen Erkenntnisse auf Doktorandenniveau präsentiert und diskutiert.

**Stichwörter:** *Webbasiertem Unterricht, Zeit Browser (\*ZB), Computerwissenschaft, Programmiersprache, Lernmotivation.*

## I. Introduction

In recent years, we have witnessed a fascinating phenomenon where various universities and colleges all over the world are experiencing a combination of advanced information technologies in academic teaching.

The increasing use of the Internet and the acknowledgment of its inherent pedagogical potential led to the creation of different software that allow web-based learning in education and the academic system (Allen & Seaman, 2004; Bonk & Graham, 2006; Harasim, 2000). Nowadays, quite a few new pedagogical models are based on unique characteristics, and have enhanced capabilities for organizing information, visual presentation, and communication between lecturers and students.

Today, traditional teaching is challenged, and veteran professors often have difficulty catching up with new technology and embracing pedagogical innovation (Guri-Rosenblit, 2005; Papo, 2001; Reeves, 2003).

The rapid development of web-based instruction and its immediate availability increase the need for exploring the learner's characteristics and needs, the media's influence on the teaching process, and the instruction system's interaction capability.

In this article I will address the findings obtained in the first stage of a PhD level mixed methods research. During this stage, quantitative data were collected and the effect of the integration of the TB on the students' motivation for learning was measured, as well as their feeling of self-efficacy. The research questions were:

1. What is the effect of integrating a Timed Browser (TB - presenting academic content by date) on the students' motivation to learn Programming Languages and on their self-efficacy?
2. What is the effect of integrating a Timed Browser (TB - presenting academic content by date) on the students' academic achievements while studying Programming Languages?
3. In what way do computer sciences student perceive the TB as a motivating factor in studying Programming Languages?

**The research hypotheses were:**

1. Integrating TB within Programming Languages Instruction will enhance students' self-efficacy.
2. Integrating TB within Programming Languages Instruction will enhance motivation to learn Programming Languages.
3. Integrating TB within Programming Languages Instruction will improve academic achievements.

**Web-based instruction & TB: The influence of web-based instruction on computer science students' motivation to learn programming languages**

Today, after three decades of integrating Internet in academic teaching, patterns can be identified in the way various lecturers use it (Malikowski et al., 2006).

The importance of this research is in understanding the essence of the web-based pedagogy and the process of integrating the internet in teaching academic courses.

In all of the studies conducted thus far, not once was there research using a unique software tool that displays contents according to dates.

Quite a few studies examined the integration of various software and / or the positions of lecturers/students working with certain software belonging to the university itself. Moreover, some studies have described an annual event where technological tools are integrated into the educational institution – however, those share a different view from the view presented in this research.

Ben-Tzvi (1990) calls the teachers "shaping leaders", believing that the shaping leader raises the students' awareness of their achievements. This causes the students to believe in themselves as a product of the teacher's faith in them. Shaping leaders leads the student to total commitment and enhances their sense of confidence. Such a teacher is a father figure to his students: he/she is a model of honesty and fairness, instilling them with a sense of belief in self. The shaping leader creates a warm emotional atmosphere, making sure to provide varied feedback on their performance and raises standards and requirements, all the while demonstrating belief in the students. Hence, the shaping leader demonstrates a prominent component of a Pygmalion-like approach to subordinates.

Brandt (1998) argues there is no limit to human beings' growth and capability of for learning more. In his opinion, educators must not underestimate what students can do, since students learn more effectively when teachers demonstrate their confidence in their abilities and provide "scaffolding" that allows them to perform well in complex tasks. Brandt researched and found that

much of the learning takes place through social interaction. All those who wish to advance learning need to know how to make room for the social context. Students must often work in pairs or in learning teams. The teacher should take a distance from the center and develop "research communities" among the students. This means that there should be a certain degree of interaction between teacher and student, beyond memorizing and providing the correct answer the teacher expects to hear; the activity should become a real discussion where students speculate and respond to their peers' ideas.

Deci, Vallerand et. al. (1991) examined teachers' styles and found that some teachers are oriented towards supporting their students' autonomy, while others are oriented towards controlling their students' behavior. The teacher's orientation affects the overall classroom climate. The results showed that students in the class of a teacher who supports autonomy showed intrinsic motivation, capability, and higher self-esteem than the students of teachers who were more controlling. The former tended to support the students' ideas and respond to all of their students' needs. This research examines the effect of the integration of TB in Computer Language courses on the students' motivation to study this field.

### **Computer Sciences Programming Languages - Possible Difficulties Why is it difficult to start learning programming?**

Studies pertaining to beginners' programming studies refer to three aspects: (1) problems and difficulties observed in beginners that involve programming; (2) error analysis and alternative approaches, method analysis; (3) beginners' approaches to solving problems. Additionally, theories were published in the attempt to explain why learning programming is fraught with difficulties.

The study of programming is a complex task performed on two axes: abstraction, which relates to concepts and principles of computer science and programming, and application, which refers to the programming language and the environment used to implement the principles. The transition between the two axes is alternate. A new concept or idea is first presented in class, and then immediately applied in a laboratory. It is then again discussed at the class level, and so forth. Accordingly, a beginner student must cope with understanding and function on both levels simultaneously. The method based on this principle, known as the "zipper" method, is recommended for teaching the new computer science curriculum in Israel (Gal-Ezer, 1995).

Experience shows that beginner students have difficulty understanding the basic concepts and principles related to programming, where they must simultaneously deal with knowledge of the programming language and the

environment in which they apply the principles that they learned by writing and running computer programs. At times, it is also difficult for them to distinguish between principles that are independent from a single programming language and other technical aspects relating to the work environment.

Armoni and Gal-Ezer (2006) referred to the five difficulty levels of programming beginners:

1. **Orientation:** Beginner students have difficulty understanding what programming is, and "What is it good for?" They find it difficult to control the different approaches to programming, and the various programming languages. In this situation, the distinction blurs between different levels of using ready-made software packages and programming;

2. **Understanding the notional machine:** Beginner students have difficulty understanding how a computer works, how to communicate with a computer, how to make it do what is intended, and so on;

3. **Understanding the meaning and syntax of a programming language** (notation): Beginner students have difficulty understanding the meaning of structures in language and using them correctly in writing the program;

4. **Specialization** (transition from novice to expert): Beginner students have difficulty making the transition to expert level, while acquiring tools and patterns for solving problems, which characterizes the experts;

5. **Performance in the workplace** (pragmatics): Dealing with technical aspects of the work environment, such as an operating system, editing files, compiling, monitoring a program's runtime, adds yet another level of difficulties.

Ginat (2001) also refers to beginners' difficulties, and distinguishes three levels of programming knowledge: (a) knowledge of basic structures used in developing algorithms; (b) development of algorithms for specific tasks; (c) decomposition of a problem to sub-tasks. He argues that mastering each stage requires mastery of the earlier stages, although mastering the earlier stages does not necessarily guarantee mastering the next. His research showed that only few among the beginning students mastered the third level. Furthermore, most of the beginners who showed mastery of the basic structures, found it difficult to apply this knowledge in the development of algorithms for solving problems.

Students' difficulties are also reflected in their reactions and levels of coping with failure in writing programs. For example, Du Boulay (1989) found that beginners react very badly to minor error messages, going so far as deleting the entire program or shutting down and restarting the computer. Similarly, Perkins et. al. (1985) found that a negative experience, failure, or encountering a difficult to solve problem can cause beginner students to give up altogether.

Bjarne (2000) further argues that the difficulties in the development of computer programs, and the difference from the abstract thinking to which students in higher education should aspire, derive from the difference between procedure oriented programming languages and object-oriented programming languages:

**Difference between Procedure Oriented Programming (POP)  
and Object Oriented Programming (OOP)**

	<b>Procedure Oriented Programming</b>	<b>Object Oriented Programming</b>
<b>Divided into</b>	In POP program is divided into small parts called functions	In OOP program is divided into small parts called objects
<b>Importance</b>	In POP importance is not given to data but to functions as well as sequence of actions to be done	In POP importance is given to the data rather than procedures or functions, because it works as a real world.
<b>Approach</b>	POP follows Top-Down approach	OOP follows Bottom-Up approach
<b>Access Specifiers</b>	POP does not have any access specifier	OOP has access specifiers named Public, Private, Protected etc.
<b>Data Moving</b>	In POP, Data can move freely from function to function in the system	In OOP, objects can move and communicate with each other through member functions
<b>Expansion</b>	To add new data and function in POP is not easy	OOP provides an easy way to add new data and function
<b>Data Access</b>	In POP, Most function uses Global data for sharing that can be accessed	In OOP, data cannot move easily from function to function, it can be kept public or private, so we cannot control the access data.
<b>Data Hiding</b>	POP does not have any proper for hiding data so it is less secure	OOP provides Data Hiding so provides more security
<b>Overloading</b>	In POP, Overloading is not possible	In OOP, overloading is possible in the form of Function Overloading and Operator Overloading
<b>Examples</b>	Examples of POP are: C, VB, FORTRAN, Pascal	Examples of OOP are: C++, JAVA, VB. NET, C#.NET

The procedure oriented languages only implement functions. The newer object-oriented languages also feature objects behaviors. An object is the objective of the program - it can be a physical thing (table, chair, etc.) but also an abstract (a course, a flight, etc.). Higher motivation and higher self-efficacy are required in order to learn computer languages. However, though it is possible to infer from language to language, there are quite a few differences between them.

Sometimes, in order to perform an identical (or apparently identical) task in 2 different languages, more logical effort and/or more commands / functions are required.

### **Motivation Theories**

The concept of motivation has been researched for many years, mainly in the fields of psychology, education, and sport. Motivation, according to Assor (2005) refers to a desire to invest time and effort in a particular activity, even when doing so is fraught with difficulties, high stakes, and failure.

Naturally, there are different theories and approaches to the concept of motivation, focusing on the different aspects of the phenomenon. The multitude of motivation theories testifies to the complexity of the concept, and the inherent difficulty in assessing it. It is worth mentioning that although motivation theories focus on different aspects, they are all based on three key factors: (a) referring to motivation as a behavior which is unique to each person, even if the conditions of the situation are similar; (b) referring to success and failure in terms of reaching or failure to reach the goal; (c) referring to the level of difficulty required for reaching the goal as a significant factor influencing the value of the achievement for the person - the higher the level of difficulty the greater the value of reaching the goal. It is important to add that there is a common assumption in the study of motivation, whereby there is a distinction between extrinsic and intrinsic motivation. Generally speaking, intrinsic motivation is defined as an investment made out of interest, curiosity, and enjoyment, while extrinsic motivation is defined as behavior intended to avoid punishment or obtain a reward, where an external reward is perceived as the cause of the behavior. The following are a number of central approaches that motivation theories are based on: The Humanistic approach, the Behavioral approach, and the Cognitive-Social approach.

### **Humanistic Approach**

This approach sees the person's needs as a source of motivation, and focuses on general processes of motivation such as self-esteem and feelings of self-fulfillment. Maslow (1954) developed a motivation theory according to which different basic needs motivate the person, either needs of "lack" in the physiological sense, such as hunger or fatigue, or need borne from "growth," which drive a person to develop their intrinsic personal potential (Maslow, 1954).

Self-Determination theory developed by Deci (1991) is based on a humanistic approach and Maslow's (1954) foundation. Three types of innate psychological needs underpin human behavior: autonomy, relatedness and competence (Deci, 1991). The desire for autonomy represents the subjective need for our feeling that our behavior is not coerced, but rather derived from our inner selves and reflects our genuine tendencies and needs. The need for relatedness

refers to the person's need to be loved by and to love others, for a sense of belonging to a wider community and for deeper relationships and honesty. The need for competence connects to the person's need to feel that he is able to reach the set goals.

Self-Determination theory posits that suppressing those needs may weaken the sense of motivation and impair its quality. Conversely, satisfaction of these basic needs will lead the person to qualitative involvement in his/her actions. The theory shows the correlation between the motives and the quality of motivation - the more internal the motives, the higher the quality of motivation. This theory constitutes the theoretical framework for intervention programs aimed at raising the level of motivation among students.

### **Cognitive-Social Approach**

This approach was the result of the inability of the theories based on the behavioral approach to explain different behavioral phenomena. This approach, resulting from the cognitive revolution, was innovative in acknowledging the important and influential role that the person's expectations have on the consequences of behavior in motivational processes. Theories based on this approach focus on socio-cognitive processes related to the person's perception of self and the environment in which he/she lives, whereby these processes derive from interactions with the environment. Different studies discussed the attitudes and beliefs of the learner as a significant factor that might predict how personal knowledge and skills will be used to determine the students' success or failure. To better understand this approach, I will review a number of consequent theories; these theories were selected because they address the way that a conceptual perception can improve performance. Bandura's Self-Efficacy (1997) is the most prominent theory. Bandura (1997) defined self-efficacy as the person's self-perception of being able to successfully perform a task, emphasizing the great significance of person's perceptions' in motivational processes and the quality of performance. Self-Efficacy theory is an example of a social-cognitive approach, since it not relates to a person's processes empowerment and improving performance. Specifically, Self-Efficacy theory focuses on several major factors: The process of the development of self-efficacy, and the effect that self-efficacy has on how the task is performed and the quality of its execution. The term "self-efficacy" refers to the individual's perception and belief in his/her abilities to perform a specific task and achieve a certain level of performance, and derives from a gradual acquisition of different skills and abilities in the cognitive-perceptual, motor, lingual, and social aspects (Bandura, 1997).

Another motivation theory focuses on the goals or achievements, and is called Achievement Motivation. According to Dweck (1961), one can identify two



main goals - learning goals and performance goals. The goal of the learner when it comes to performance goals is to avoid negative judgment and seek positive feedback. Conversely in learning goals the goal of the learner is to understand the contents in depth, to invest effort, and seek involvement in the learning process. Performance goals are characterized by an external source of motivation, such as a good grade or the teacher's appreciation, and learning goals are characterized by an internal source of motivation, such as increasing performance quality and controlling it, interest, and curiosity.

### **Self-Efficacy**

Self-efficacy is a person's judgment of his/her capabilities in organizing and executing a course of action required to attain a specific performance (Schunk, 1991, p. 207). *"Since Bandura's (1977) seminal article on self-efficacy, much research has classified and extended the role of self-efficacy as a mechanism underlying behavioral change, maintenance, and generalization"* (Schunk, 1991, p. 207). Self-efficacy beliefs influence what one wishes to do, and motivate the degree of effort and persistence. Bandura indicated that these same beliefs influence the outcomes of the regulated activity (Schunk & Pajares, 2001). An individual's concept of self-efficacy can cause that individual to perceive his/her level of ability to perform in direct correlation to the perceived thoughts of self-efficacy. Two people with the same skill level can perform differently depending on the level of individual self-efficacy which these persons believe they have (Bandura, 1993, p. 118)

According to **Self-Efficacy** theory, the process of shaping the self-efficacy perception is based on the entirety of the previous experiences with success and failure in the context of educational tasks. The theory emphasizes the social aspect in learning and motivation processes. Results of previous studies shed light on the affinities between the students' sense of self-efficacy and past experience, feedback, encouragement and support; students who feel effective when performing academic tasks will exhibit greater investment in the learning process, longer persistence when coping with challenges, and better achievements (Schunk, 1991). Many studies have shown a direct correlation between positive feedback and increasing intrinsic motivation, and the direct positive correlation between negative feedback and a decrease in intrinsic motivation. Schunk (1991) focused on processes that promote a high self-efficacy perception for tasks and the development of intervention programs designed to enhance the students' self-efficacy. Schunk's conclusions showed the different ways to enhance students' self-efficacy, for example setting specific and short-term goals that reinforcing the student's assessment about the ability to reach these goals. Another way that contributes to self-efficacy is teaching problem-solving strategies.

Another theory, emerging from the Cognitive-Social approach, is the Attribution Theory, which focuses on the influence of the student's expectations, such as the expectation to succeed or fail the different requirements (such as exams, quizzes, assignments, etc.) on the value that the student attributes success of failure in the academic requirement. It is important to note that the value of the achievement is determined individually and is subject to effects from the attitudes of the environment, the level of difficulty required for reaching the goal, and the significance of the achievement and the feelings of success and pride of those who manage to succeed (Schunk, 1991).

According to the Self-Determination theory (Deci et. al., 1991), supporting efficacy will increase the motivation and allow its continuity. Supporting efficiency will be possible through challenges, feedback on performance, peer acceptance, and parental involvement. Research has shown that the more involved the parents and teachers in their children's actions, while supporting autonomy, the greater the children's motivation. Research also points to the importance of the freedom of choice in the process of self-determination. It was found that when students were allowed to choose their tasks they were more intrinsically motivated than those who had their tasks dictated for them (Deci et. al., 1991).

In conclusion, one of the major roles of the education system and the teacher is to create a learning environment with a supportive social climate, which allows the learner to perceive learning as a process that allows the formulation and realization of values and personal goals. The assumption is that every teacher knows the composition of his/her class (the students' programming background), the class's unique difficulties (for example, lack of study time or 'poor' theoretical background), and based on these data, he/she can adapt the software so that the largest common denominator of the class will benefit and gain understanding and professional benefits from using it.

### **Research Design**

This mixed-methods research combines qualitative and quantitative research methods, and at 4 points in time: (1) In the beginning of the fall semester (October, 2013), a questionnaire was administered to the two groups (80 students) seeking to examine their self-efficacy and motivation; (2) Validation of the questionnaire and analysis of the data emerging from the students' results (at this time); (3) In April, 2014, I conducted about 10 semi-structured interviews with students of the experimental group in order to explore the students' attitudes regarding the use of a TB. (4) In the end of the spring semester (June, 2014) and in fact in the end of the academic school year, I will once again administer a questionnaire to the two groups (80 students) with the goal of examining the changes.

At this time I should already have the students' academic grades, and I will be able to analyze them from an annual perspective (with correlation to their initial high school graduation grades).

**Research Variables:** (1) **Dependent variable:** effect of TB on: motivation, self-efficacy (academic and applicable) and academic achievements, students' perceptions. (2) **Independent variable:** integration of TB, learning environment.

**The Research Population** consists of students enrolled in professional training programs, prior to their recruitment to the Israeli Defense Force (IDF), aged 17-20. I will use two groups of student in this research, each containing around 40 participants.

The experimental group will undergo the programming language learning process with the use of the TB, whereas the control group will learn programming language in traditional ways without the use of TB.

All the students enrolled in my college (and included in this research) majored in computer science in their high school. They passed their tests successfully, as well as completed a final project on the subject. Without these prerequisites they would not have had approval from the Ministry of Education to enroll at the college.

**Main research goal:** To develop a model of a Timed Browser (TB - Presenting academic content by date), integration in Programming Languages Instruction within the Computer Sciences.

**Secondary research goals:** (1) To examine the effect of integrating TB in Programming Languages Instruction within the Computer Sciences, regarding, motivation to learn, self-efficacy, and academic achievements.

### **Closed-Ended Questionnaire**

The questionnaire was constructed by a statistics expert specifically for this research.

It is very important for me to find the differences between those who studied procedure oriented programming language or an object oriented one.

### **The Importance of This Research**

On the theoretical level, this research can contribute to the understanding of how integration of TB within programming languages instruction can affect motivation to learn and promote academic achievements. On the practical level, the research will offer a pedagogical management tool that can benefit teachers and students in managing learning and teaching using IT.

### Preliminary Findings

Table 1 presents the results of a t-test for independent samples between the two research groups: students using the browser in their learning and those who do not learn with the browser. Since the current point of measurement is the beginning of the school year, no differences are expected between the two groups regarding the three research variables.

**Table 1.**

**t test for independent samples: Differences according to teaching method**

	Without Browser		With Browser		
	N=41		N=40		
t	S.D	M	S.D	M	
-0.84	.49	2.07	.57	1.97	<b>Learning motivation</b>
-1.75	.58	2.29	.66	2.05	<b>Self Efficacy</b>
-2.08*	.63	2.19	.71	1.88	<b>Performance efficacy</b>

\*  $p < .05$ . \*\*  $p < .01$ . \*\*\*  $p < .001$

The finding of the three variables show that the group that did not use the browser is slightly better, but as expected, the difference is not significant. Regarding the "performance efficacy" variable, the difference between the groups is significant, and perhaps it derives from the fact that the measurement took place some 3-4 weeks into the school year, so the students had already experienced the learning method.

Tables 2 and 3 present the analyses of t tests for independent samples between the two research groups based on the participants' background variables: gender and programming language. These analyses were conducted to examine already in the beginning of the research if there are differences among students regarding these variables.

**Table 2.**

**t test for independent samples: Differences According to language**

	Procedural		Object Oriented		
	N=17		N=64		
t	S.D	M	S.D	M	
-0.86	.46	2.12	.55	1.99	<b>Learning motivation</b>
-2.96**	.62	2.55	.60	2.07	<b>Self Efficacy</b>
-2.44*	.77	2.39	.64	1.94	<b>Performance efficacy</b>

\*  $p < 0.05$ . \*\*  $p < 0.01$ . \*\*\*  $p < 0.001$

The analysis reveals that indeed these findings distinguish the students already in the initial stage. Regarding gender, it can be seen that there is a systematic difference among variables, so that girls are significantly better than boys. In the programming language variable, we can see that programmers using the procedure-oriented language scored higher than their peers using the object oriented language in all three variables, but with the "learning motivation" variable the difference is not significant. In addition to the analysis of differences via t tests for independent samples, One Way ANOVA was also conducted to identify possible differences based on the type of language. It has to be noted that use of One Way ANOVA rather than t test for independent samples derived from the fact that the analysis included three groups rather than 2 groups in the variable analysis (gender and language).

As can be seen from the results of the measurements conducted, the findings are inconclusive since the data were collected at the beginning of the course. It is the intention interest of this study to collect further data at the end of the learning process in order to determine whether and to what extent the integrated TB can promote motivation and self-efficacy to learn programming languages, and to create a more structured, planned, and systematic approach that has yet to come to full realization in view of the educational innovation in higher education.

The findings show that mapping individual and personal factors may have a potential impact on innovation (2005 - Marieke), and can assist in the process of identifying and targeting earlier efforts, which can be channeled towards maximizing success in the classroom.

There is no single and absolute theory that provides the solution for formulating a general framework for embracing innovation. Additionally, the education system in general and academia in particular may contain a variable number of initiatives originating from individual projects from teachers/lecturers. A structured, planned, and systematic approach that has yet to come to full realization in view of the educational innovation in higher education. In this context, we should address Collis, & van der Wende (2002) research, which aimed to define models for technology and change in higher education.

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