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Education in the digital age

In *The World is Flat*, Thomas Friedman (2005) argues that technology, economics, and population growth have created a global economy where competition favors countries with trained workers willing to accept low wages. The science and technology necessary to produce and sell mass-produced goods and services has spread across the globe, and the high-wage economies of developed countries reward those who can do innovative work and punish those who can not.

As a result, schools and universities face a new challenge. In the old industrial economies of developed nations, graduates who had mastered basic skills in reading, writing, and mathematics were able to find good jobs. But young people in such countries today need to think less like assembly line workers and more like professionals who solve problems that do not have easy answers. They need to learn judgment and discretion rather than obedience. Skills that once were the preserve of the elite are increasingly the prerequisite for entry-level work of any kind. In the digital age of global competition, schools and universities have to train young people for creative thinking, collaboration, and complex problem solving.

Here I argue that the same technologies that make innovative and creative thinking critical skills for the future also make it possible for students to prepare for that future through well-designed and sophisticated computer games for learning. Computer games, in other words, may be a critical part of the future of education in the digital age, and while in this analysis, because of my own particular expertise, I draw examples primarily from the United States, the issues hold for any nation that wishes to prepare itself and its citizens for our changing world.

The Power of Games

Building things is fun. With sand, with Lego bricks, with Lincoln Logs, paper scissors and tape, clay, papier mache, wooden blocks, cardboard, paper bags, paint, paper and glue, or bailing wire and twine. It is especially fun for kids, but it turns out that building things is so much fun that it is often as much fun building things in virtual worlds as it is in the real one. That's why some of the most popular computer and video games let players build things. In these games—which go by the unfortunate moniker *God Games* for reasons I will explain in a moment—players can design and run complex projects over time: cities, railroads, zoos, construction sites, amusement parks, and so on. They develop and manage a business (which is why so many of these games have the word «Tycoon» in their title), or in the case of SimCity—the most famous construction game of all—build and lead a municipality as it grows from tiny hamlet to urban sprawl.

SimCity is a great game. It is fun to play. It is interesting. It is about things that matter in the world. It involves complex and important concepts in mathematics, science, history, sociology, and economics. But it is not necessarily ideal for learning. And understanding why helps show what the next steps to a system of education might look like.

Why not SimCity

The game *SimCity* is based on a simulation that models complex urban systems. In *SimCity*, players take control of an urban grid. They design and run a city by maintaining a balance between a growing population, environmental changes, urban and economic development, and social issues such as crime and transportation. They play a role that incorporates elements of mayor, urban planner, and city government official, planning and managing the growth of the city over decades and even centuries.

Players in *SimCity* begin to understand the complexities of urban ecology as they make choices and encounter interdependencies and trade-offs in running their city. For example, if you put more parks in a city in the game, the cost of public utilities goes up because you have to keep the parks clean. If you put an industrial site next to residential housing, the residential land values fall and the crime rate rises. As a result, a player must decide whether to raise taxes, decrease the green space, move the industry, or risk urban flight—or, more realistically, decide which combination of these choices and in what measure will lead to the best long-term outcomes for the city. In this way *SimCity* makes visible how human choices affect environmental outcomes, and lets players see how those outcomes then shape future choices.

Studies have shown that *SimCity* can help students learn about urban geography and community planning in social studies classes (Adams, 1998; Frye & Frager, 1996). But while a game like *SimCity* can help players think about complex systems, there are also real limitations in using this particular game—and more generally this kind of game—for educational purposes.

In *SimCity*, the city that you create and maintain does not always represent an actual place—and certainly not the places most children live when playing the game. The simulation model may represent realistic patterns of great complexity, but the issues are not necessarily issues that resonate to the world players inhabit outside the game. Space is compressed and time dramatically expanded in the game. Changes occur on a wide-ranging geographical scale, presenting a macro level view of how cities function. Players manage an entire city that undergoes dramatic transformation in a matter of minutes or hours, whereas real cities grow and change slowly. We know that complex ecological and social processes look very different at different timescales; so the fast-paced changes may give a distorted picture of how problems are resolved in the real world (Latour, 2000; Lemke, 2000).

Most troubling, though, for *SimCity* as a context for learning about the world—if we ignore the monster attacks and alien invasions that are part of the game—is that players in the game act as virtual dictators (Beckett & Shaffer, in press; Starr, 1994). Much of the work of planning and running a city depends on responding to the needs of constituents and interest groups that often do not even understand clearly what their own goals and agendas are for urban development, or how their own desires may be mutually contradictory. Thus, much of the work of running a city is in trying to figure out what people want, and then incorporating those desires into a workable plan for action through the political process: a process that is almost completely absent from the game. There is no context (such as a planning or city council meeting) in which players explain and justify their actions—their purpose for placing industrial sites adjacent to residential ones, or funding road construction instead of the development of greenspace—or submit their plans and intentions for approval.

This is why *SimCity* is called a God Game. Players are not responsible for any social process of decision making within the virtual world. They face consequence for their actions, but they are free to do whatever they want, however irrational, destructive, or unrealistic.

Urban planning

SimCity is fun to play, and helps players develop intuitions about urban issues. But players are not learning to think about how cities work from the perspective of any real professional community. Let's consider, then, a game about urban ecology that actually *does* get players thinking the way professionals think about the complex and ill-defined problems that urban areas face.

Urban planners are great examples of innovative professionals. They develop land use plans that meet the social, economic, and physical needs of their communities. To do their job, urban planners have to have a deep understanding of both social and scientific issues. They use sophisticated tools to solve complex problems, including geographic

information systems (GIS) that make it possible to ask creative «what if» questions. Learning to think and work like an urban planner means learning to use GIS models and other tools to solve complex real-world problems in which science, society, economics, and technology intersect.

The American Planning Association describes activities and abilities that urban planners need to do their job: a description of what it means to see urban landscapes and think about urban problems from the perspective of a planner. According to the planning association, urban planning involves «developing plans for how land is used..., working with the public..., analyzing problems, visualizing futures, comparing alternatives and describing implications, so that public officials and citizens can make knowledgeable choices..., managing the planning process itself, in order to involve interest groups, citizens, and public officials..., [and] being technically competent and creative» (see Beckett & Shaffer, in press).

Notice that several of these important characteristics are missing from the game *SimCity*, notably working with the public, describing implications so that public officials and citizens can make knowledgeable choices, and managing the planning process itself. Part of the mandate of the planning association is that planners be creative. Like all professionals, planners can not simply follow a rulebook to solve problems.

Planners develop their particular form of innovative thinking through a practicum, working to solve planning problems with the help of peers and mentors. So the epistemic game *Urban Science* is based on such a practicum.

Urban Science

The game begins when players get a project directive from the mayor to the city planning department: create a detailed re-design for the local pedestrian mall in their city. Players get a city budget plan and letters from concerned citizens about issues such as crime, revenue, jobs, waste, traffic, and affordable housing. Players go to the pedestrian mall, where they conduct a site assessment, as real planners do, and have a chance to hear from concerned citizens and community groups, such as the Urban League, Chamber of Commerce, a historical preservation association, and so on.

Next, players use iPlan, a planning microworld that contains an interactive GIS model of the downtown area, to create a redevelopment plan. With iPlan they develop a *preference survey*: an instrument planners use to assess the response of stakeholders in the community to possible planning alternatives. Based on the response they receive from surveys from the different stakeholder groups, players use iPlan to develop a plan to address the interests of the different groups.

For example, if a player wants to raise the number of jobs to satisfy the Chamber of Commerce, she might rezone part of the pedestrian mall for a large retail store. iPlan would show her that the number of jobs projected for the neighborhood goes up under

that plan, but the model also would show how other issues, like waste and traffic, are affected by the new store—issues that might be problematic for other stakeholders. Just like real planners, players have to balance the overall impact of their proposals against the costs and benefits—economic, social, and environmental—of alternative choices. And they have to do so within the social, economic, and ecological system of the city. After completing a land use plan, including a revised downtown zoning map, players present their proposals to a representative from the city planning office, justifying their proposed plans.

In other words, this is a game played by the rules of an urban planning practicum: a city planning simulation. The virtual world of the game is modeled on the real world of the city players live in, and the real work of planners who shape that city. Players are redesigning a city, but it is *their* city. They can see and touch the places they are redesigning, and can see how those changes might make their lives and the lives of those around them richer and more satisfying. However, their choices are constrained by the economic, social, and physical realities of life in a city, and by the norms and practices of the profession of urban planning.

Becoming planners

One study, conducted by researcher Kelly Beckett, tested *Urban Science* as part of a summer program for students from disadvantaged backgrounds (Beckett & Shaffer, in press). In the study, eleven high school students played for a total of ten hours over the two days of a single weekend in the summer. All had volunteered to play the game, and received community service credit for playing.

Beckett interviewed players before and after the game. The interviews included questions about ecology and urban planning, and players were given urban planning transfer tasks designed to assess whether they could use concepts, skills, and values from the game to solve problems like an urban planner. Players also completed concept maps representing diagrammatically their understanding of the issues and interest groups relevant to their city.

Beckett's interviews showed that these players knew very little about urban planning before they started the game. In the course of the game, though, they learned to read and interpret documents the way urban planners do. They learned to conduct a site assessment. They learned to create a land use plan. They learned how to make a project presentation. And they learned to put these skills together, in the way urban planners do, to create a convincing proposal for the development and renewal of their city. They developed these skills and abilities in the same way urban planners do, supported by adults who held them accountable to professional standards of excellence.

Beckett found that after the game, players had a better understanding of urban ecology. Before the game, less than 10% of the players could explain what the word «ecology» meant. After the game, more than 80% could, and understood what it meant to think

about the ecology of a city the way an urban planner does. After the game, players' thinking about urban issues as measured in concept maps became more complex, including on average 72% more connections between issues and stakeholders, and taking into account on average 20% more factors that impact city planning. After the game, every single player Beckett interviewed said, in one way or another, that playing the game changed the way they think about their city. One player said walking down the street after playing the game she tended to «notice things, like, that's why they build a house there, or that's why they build a park there.» Another said: «I'm looking at connections a lot closer now, usually you'll see connections but you don't think about them.»

Beckett also asked players to comment before and after the game on the problems of a small town that had too much waste for its landfill. Before the game one player's solution was just to «look for a new landfill.» After the game, though, the same player gave a much more detailed response to a similar problem dealing with the closing of the town recycling station:

> Okay, well, first of all, they should have not closed down the recycling plant. They could have cut other stuff, or they could've raised taxes to increase revenue.... I think they should keep a recycling plant because they should be helping to reduce the amount of waste.... They could export the trash, but then that would cost a lot more money too, and they're making budget cuts....

Notice how the proposed solution after the game is specific, technical, and innovative about how to solve this planning dilemma. The player analyzes the problem, using knowledge and values from the planning profession, using planning skills to frame the problem in terms of different alternatives (raise taxes, export the trash, budget cuts, and so on). The player considers each alternative, and how it might impact the many dimensions of a complex urban ecology.

Different games

SimCity is a commercial game, designed primarily for entertainment. *Urban Science* is designed to recreate an urban planning practicum. *SimCity* can be a useful educational tool for starting discussions about the interconnectedness of urban systems. But it was primarily designed to be fun to play, and thus to sell well in the marketplace of commercial games. *Urban Science* was designed to develop innovative thinking.

Fun and learning can be quite compatible, of course. Racing enthusiasts can use the high-fidelity simulation in the racing game *Gran Turismo 4* to learn about a car's driving dynamics and a track's layout (*Ford GT vs. GT4*, 2006). But what makes *Urban Science* special is that it is based on what we already know about how people learn to be innovative thinkers, and on how that kind of thinking is used to solve real problems in the world outside of the game. In this sense, it is an example of a very special kind of game that may point the way to the future of learning.

Building Epistemic Games

Urban Science is an *epistemic game*. In epistemic games, players learn to think about real problems by doing in game form what professionals in the real world do to learn innovative and creative thinking—the kind of thinking that young people need in the digital age of global competition.

Professionals develop the skills, knowledge, identities, values, and epistemology of innovation in professional practica: places where novices work on professional problems, and reflect on that work with peers and mentors. In this general sense, the architectural design studio, capstone courses in engineering, journalism and urban planning, and mock negotiations are all similar in their overall structure. But the specific kinds and forms of reflection-on-action in each practicum matter, because they provide a map of the different professional vision of each practice. The reflection-in-action, or thinking on the fly, of a professional is formed as cycles of action and explicit reflection-on-action is internalized as guides for future action. Epistemic games are based on the idea that practica have evolved, over time, sophisticated techniques for helping novices develop the ways of thinking of a profession—and that these practices can, with new technologies, be adapted so that younger students can develop innovative and creative ways of thinking at an early age.

Questions

Epistemic games are built by asking a series of questions. The questions may seem obvious once stated, but they are, in fact, only made possible by the power of computers to create virtual worlds.

Any epistemic game starts with the question: What is worth being able to do in the world? There are many things that we want young people to be able to accomplish in life. Some things matter for economic reasons, like being able to balance a checkbook. Some are more practical, like being able to change a flat tire. Others are about self actualization, like being able to appreciate a work of art or a piece of music. Or about interpersonal relationships, like being able to talk constructively about conflict. Some are about citizenship and some about health and some, like learning to read, are about more than one of these things in different ways at different times.

Whatever is worth doing, though, some group of people in society knows how to do it. If there is not such a group, one has to assume the thing is not worth doing. Or if it still is worth doing, it seems strange that we would expect children to do what adults can not. So the second question is: Who knows how to do this kind of thing and how do *they* learn how to do it? This second question leads a careful investigation of how the skills, knowledge, identities, values, and epistemology are created for a group of people who solve some important kind of problem in the world.

Finally, we ask: how can we make these learning practices available for others? Computers make it possible to create virtual worlds, so what kind of virtual world will make it possible to act—and to reflect on that action—to learn to address this kind of problem? The solution almost always involves some piece of technology that makes a simulation possible, but it also always involves more than just technology, because a game is always about more than just the underlying simulation. The virtual world of an epistemic game recreates learning practices that almost always involve people as well as things, reflection with peers and mentors as well as action.

This kind of analysis and game design are possible across a range of «things worth doing»—which suggests that epistemic games may be a way to rethink, and perhaps rebuild, our system of education.

Rebuilding education

With epistemic games, young people don't have to wait to begin their education for innovation until college, or graduate school, or their entry into the work force. In *How Computer Games Help Children Learn* (Shaffer, 2007), I describe a number of epistemic games like *Urban Science* in which players learn to think like professionals: *Digital Zoo*, where players become biomechanical engineers; *Escher's World,* where players become graphic designers; *The Pandora Project*, where players become international mediators; and *science.net*, where players become science journalists. These examples show what effective learning might look like in a high-tech, global, digital, post-industrial world. To make that image a reality, however, games like these will need to change our understanding of classrooms and commercial games, formal and informal learning. And one path to those changes is to think about epistemic games in *third places*.

The term third place was coined by sociologist Ray Oldenburg (1989) to describe cafes, community centers, coffee shops, and general stores. These are neither homes nor work, and thus are the «third places» in people's lives. Third places are places where people regularly go to talk with friends and «hang out»—to build community, share triumphs and losses, and in the process deal with issues, problems and concerns that can't be fully expressed within the confines of the family or the structures of a job.

Epistemic games at the moment are a kind of third place—or perhaps more appropriately a third *space*—between formal schooling and more traditional commercial games. Although some epistemic games have been used and tested in school settings, most have been developed and played in out-of-school contexts: after school hours at a community center, on weekends as part of an outreach program, in conjunction with the 4-H or Girl Scouts, or as part of a summer program for kids.

More than 2.5 million elementary and middle school students in the United States spend time in organized after-school programs every week. Historically the main purpose of such programs has been to provide a safe place for children between the time school

ends and the time their parents come home from work. But many of these programs are also trying to provide opportunities for students to continue their education in a different—and perhaps more meaningful—fashion. One way to do this is through video or computer games like the ones I have described. Perhaps in the not too distant future, epistemic games may also be a part of what games researcher Constance Steinkuehler (2005) has called *virtual third places*: multiplayer online worlds like *Second Life* or *Quest Atlantis* where young people and adults can gather from across the world rather than across a city or neighborhood to work on meaningful projects.

The reason I focus on how these games are played out of school is that schools, as currently organized, make it difficult to prepare kids for innovation through epistemic games. It is hard for teachers to spare the time from getting students ready for the next standardized test, and, not surprisingly, innovation is difficult to accomplish in 40-minute chunks of time, spread from room to room and subject to subject throughout the day. So to develop and test epistemic games we look outside of schools, to places where children have time to work on complex problems in-depth—and where adult mentors in these games can focus on students' innovative thinking rather than on their performance on tests of basic skills.

Our modern school system is difficult to change because that change is politically as well as financially expensive. If schools are going to adapt to new social and economic conditions, we need to develop viable alternative models of learning that excite parents, teachers, administrators, business leaders, politicians, and others with a stake in the schools. And of course it would be important that these alternatives actually help prepare kids to be innovative thinkers in a complex, post-industrial world. We can develop epistemic games outside of the network of traditional schooling, not to compete with the schools, but to show what can happen when we think—quite literally—outside the boxes of the traditional school building, classrooms, schedules, subjects, and curricula. If this puts pressure on schools, or helps use see a way to help schools do a better job of preparing students for life in a high-tech, digital, world of global competition, so much the better.

Along the way, epistemic games played in the third places of childhood can also address important needs in the short run. They are one way to create incentives for students to take advanced courses in technical subjects in school, which is one of the recommendations of a recent national report on responses to globalization (Committee on Science Engineering and Public Policy, 2006). More generally, such experiences are productive for adolescents and for middle school students in particular. As Bandura (2006) points out, middle school marks a difficult transition for many students. Leaving the relatively protected world of elementary education, many face their first experiences of academic, athletic, or social difficulties. Mastery experiences like those that come through playing epistemic games reinforce adolescents' sense of self and self-efficacy in a critical period of academic and career

development. Middle school is when many students begin to opt out of mathematics and science, and studies suggest that the career trajectory for many students gets crystallized quite early. Moreover, students returning to school after enrichment programs have a *splashdown effect*, seeing the school in a new and more productive way (Stake & Mares, 2005). Epistemic games can thus help young people take important steps toward success in school and in life in the digital age of global competition.

But the point of epistemic games is not that they can do the same things that schools do only better—or for that matter, that they can do the same thing that commercial games do only with more math, science, and social studies in them. The point is that they are a fundamentally different way of thinking about learning based on a fundamentally different way of thinking about thinking. They are about the kind of thinking and learning that kids need in a changing world.

Epistemic Games and School

Of course, both schools and commercial games might benefit from becoming more like epistemic games. It is certainly possible to imagine that schools might someday be more about epistemic games and less about the game of *School* and its standardized answers to standardized assessments. That would certainly begin to address the problem of preparing young people for innovative thinking in a competitive world. But education based on epistemic games could also go a long way toward solving other problems that plague our schools today.

We know that what kids learn in school doesn't stick with them very well. It doesn't transfer much beyond the tests students take. Sometimes it doesn't even transfer that far. Most people study mathematics every year beginning in first grade, but many can't do much more than perform (often poorly) the functions that are already built into a 99-cent calculator. In the most recent Trends in International Mathematics and Science Study only 7% of students in the US scored at the most advanced level in mathematics (Friedman, 2005).

But this disconnect between facts and rules that students memorize and knowledge they can use to solve real problems simply does not happen in epistemic games. Epistemic games are based on making and applying knowledge. Instead of learning facts, information, and theories first and then trying to apply them, the facts, information, and theories are learned and remembered because they were needed to play the game—that is, to solve some real world problem—in the first place.

Of course, epistemic games like *Urban Science* are about facts, and lots of them. Students playing *Urban Science* had to learn a complex set of zoning codes, and to understand what they meant and how to use them. They had to figure out the relationships among complex variables such as the crime rate, housing stock, land values, tax revenue, waste, transportation, and pollution. But this information was not merely a set of facts to

be memorized. It was knowledge put to use as part of a professional way of thinking—the kind of learning that students need to prepare for innovative work.

Epistemology matters

The biggest change, though, in organizing schools around epistemic games would be to stop thinking about the goal of school as learning math, science, and social studies in the first place.

This seems like a radical thing to say because the traditional intellectual disciplines have been the focus of schooling since... well, as long as we have had modern schools. Whatever the hidden curriculum of social discipline may be, the explicit curriculum of school is about learning *the basics*: the fundamental ways of thinking that students will use no matter what they choose to do after school.

But wait a minute. If mathematics, science, and history matter because they are *ways of thinking*, then accounting, medicine, and journalism matter too. They are also ways of thinking. Mathematicians, scientists, and historians have distinct epistemologies that shape how they see the world: what I have called elsewhere *epistemic frames* that combine skills, knowledge, and values within particular ways of deciding what is important and explaining and justifying action (Shaffer, 2007).

The epistemic frame of a professional research mathematician is not any more *fundamental* than that of a statistician, though. Or an accountant. Or a surveyor. Professionals in those fields use mathematics too, but they learn and use knowledge and skills about numbers and objects in space in the context of solving different kinds of problems than professional mathematicians. Accountants and surveyors don't have much use for formal proofs, for example, geometric or otherwise. It may be important to them that *someone* be able do such proofs, but they think about quantitative and spatial information in a different way. Similarly, it is not important to a professional mathematician to be able to use logistic regressions to find patterns in complex data, or to accurately map complex parcels of land based on ageing and out of date records. But it is important to him or her that *someone* be able to it—assuming of course he or she ever wants to do things like buy a house. All of these professions are important. But which are more fundamental—in the sense that everyone should learn to think using that epistemic frame—is an open question.

Computers now make it possible for young people to learn through epistemic games based on the way professionals train for innovative thinking. So the question is no longer: How can we make sure every student learns math—or science, or history? Rather, we need to ask: Which ways of thinking—which epistemic frames—should students develop to become fully actualized and empowered citizens in a post-industrial society?

It may be that learning to develop the epistemic frame of academic mathematicians, historians, and research scientists is an important end of the educational process. Or it

may be that the epistemic frame of (for example) accountants, journalists, and foundation program officers is a more useful general way of thinking about issues numeric, civic, and scientific in the body politic. Or we might decide fundamental skills for life in a global society and economy include a wide range of epistemic frames, and that different combinations of epistemic frames matter for different students. The fact is that we won't know until we have enough epistemic games (and enough players of epistemic games) to see which ones are the most interesting, most transformative, and most useful, how different games fit with one another, or how to organize a whole curriculum of such games.

Which frames we focus on is a practical and a moral—and thus ultimately a political—question. But it is a question that points toward a very different kind of education, and away—far, far away—from the direction our schools are moving now.

It is absolutely critical that schools make sure all children learn to read and write. But in today's world it is, quite simply, not enough. It is not enough for our children or for our economic survival if education is only about giving kids basic skills for jobs that no longer exist. We have to start preparing children—all children, rich and poor, at risk and gifted, urban, suburban and rural—for the challenge of innovative work.

And epistemic games are a way to do that.

Epistemic games use the power of new technologies to change the way we think about education. In epistemic games, the same technologies that place a premium on innovative practices make those practices accessible to young people as never before. With epistemic games, the same technologies that make industrial schools largely irrelevant in preparing students for productive and satisfying lives make it possible to invent a new way of teaching and learning. Epistemic games may not be the only way to do that, but they are one way to do it.

There are, of course, some who feel that video games are a passing fad—or perhaps worse, a pernicious drug, stupefying players young and old into wasting hours of time and millions of dollars on mindless, senseless and often violent activities (Anderson, 2004).

The case has already been made by others that video games are complex, challenging, and in the end, important (see, e.g., Gee, 2003; Johnson, 2005). Here I have argued that the virtual worlds of video and computer games are occasions for learning, and the opportunity they present is to learn by doing things that matter in the world on a massive scale. People who do things that matter in the world—professionals in the broad sense of anyone who uses judgment to solve complex problems that can't be addressed by rote formulas—learn to think through practica. In these practica, professionals-to-be take action and reflect on that action with peers and mentors. In the process, they develop the skills, knowledge, identities, values, and epistemology—the epistemic frame—of their profession. They develop a professional way of seeing, thinking, and acting about important problems.

The virtual worlds of computer and video games make it possible to recreate these practica and make them available to young people through epistemic games: games designed to recreate the epistemic frames of innovative thinking. These games make it possible to move beyond disciplines derived from medieval scholarship and taught in schools designed in the industrial revolution—to a new model of learning for a digital culture and a global economy.

Seymour Papert wrote that when it comes to learning, what *can* be done is a technological question, what *should* be done is a pedagogical question, and what *will* be done is a political question. So in the end the future of education will depend not only on whether epistemic games work, but on whether we have the will to change how we think about thinking and learning in a changing society.

Noter

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