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Learning Games or Learning Stimulating Games: An Indirect Approach to Learning Stimulating Effects from Off-the-Shelf Games

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ABSTRACT

Playing games to support learning is a classic concept that is seeing a revival today in the widespread use of computer games. Inserting educational content into various types of computer games is a strong trend that some researchers have described as a mad rush. The aim of this article is to discuss possible learning stimulating effects of commercial off-the-shelf (COTS) games in a long-term perspective. We argue that COTS game players' attitudes towards learning may change in a positive direction even in cases where direct learning outcomes are not aimed for.

This may be the case when in-game skills are described in terms of real life skills commonly associated with higher education. When a high enough skill level is achieved, then and only then is the player rewarded with pleasant in-game experiences.

The causality of the perceived experience is ideally that with high enough skills, positive stimulation follows. The contribution of the gaming lies not in the short-term learning outcome, but rather in the long-term effects it may have on future educational choices. Even if such a game do not fulfil the criteria for learning games it may still be seen as a learning stimulating game.

KEYWORDS

Learning stimulation, Computer games, Commercial-off-the-shelf games, Learning stimulating games, Games and learning.

1 INTRODUCTION

Computer games may have an effect on what learning is going on in a society in several ways. With a direct approach to game based learning, the goal is to train the player using computer games containing relevant information and/or setups supporting the learning process of the player, either using specifically developed educational games, or by using Commercial Off-The-Shelf (COTS) games for learning purposes. In addition, a possible long-term learning stimulating effect of playing computer games may exist; games that reward players with increased (simulated) skills in areas commonly associated with higher education could play a role in attitudes towards future academic studies.

2 RESEARCH SUPPORTING COMPUTER GAMES IN LEARNING CONTEXTS

Research in the area of specific advantages of computer games as educational tools has pointed out several aspects where games fit very well into key patterns of successful learning. As Gee points out, these aspects need not be related to such features that are often noted regarding computer games, such as the graphics*: "The secret of a videogame as a teaching machine isn't its immersive 3-D graphics, but its underlying architecture. Each level dances around the outer limits of the players abilities, seeking at every point to be hard enough to be just doable"*. [1]

Indeed, the idea to use games as learning tools emerged long before computers with today's ability to render realistic game worlds existed. Early examples include large simulation games such as the RAND corporation's logistics simulator modelling relevant activities of the US Air Force supply system with players acting as inventory managers [2], and the first business simulation game being used in college education as early as 1957 [3]. Duke suggested in 1974 that games might become an entirely new form of communication in education [4], and in a more computer dense landscape 30 years later Woods expands on this idea, claiming that *"…gaming is a future's language, a new form of*

communication emerging suddenly and with great impact across many lands and in many problem situations". [5]

Their underlying architecture, as Gee puts it, separates computer games from many other activities in modern society that instead reward the participant with easy instant gratification, as remarked by Steven Johnson in his analysis of popular culture: *"You'll often hear video games included on the list of debased instant gratification that abound in our culture, right up there with raunchy music videos and fast food. But compared to most forms of popular entertainment, games turn out to be all about delayed gratification – sometimes so long delayed that you wonder if the gratification is ever going to show"*. [6]

The positive aspect of something being hard, and the danger of making things too easy, is also discussed by Papert: *"What is best about the best games is that they draw kids into some very hard learning … The fact is that kids prefer things that are hard, as long as they are also interesting"*. [7] A high difficulty level can also act as a strong motivator to collaboration in games that support this, as described by Hämäläinen et al. regarding ways of making players cooperate rather than play separately from each other: *"… one option is to design highly difficult and even frustrating puzzles. In fact, apparently impossible tasks seem to be one of the strongest factors promoting player collaboration. After all, games are all about facing challenges and succeeding after a series of failures"*. [8]

This touches on the Practice Principle, outlined by Gee as one of several principles involved in successful learning situations: *"Learners gets lots and lots of practice in a context where the practice is not boring (i.e. in a virtual world that is compelling to learners on their own terms and where the learners experience ongoing success)"*.[9] Among other notable such principles are the Achievement Principle: *"For learners of all levels of skill there are intrinsic rewards from the beginning, customized to each learners level, effort, and growing mastery and signalling the learners ongoing achievements"*, the Ongoing Learning Principle (abbreviated): *"The distinction between learner and master is vague, since learners … must, at higher and higher levels, undo their routinized mastery to adapt to new or changed conditions …"*, and the Probing Principle: *"Learning is a cycle of probing the world (doing something); reflecting in and on this action and, on the basis, forming a hypothesis; reprobing the world to test this hypothesis; and then accepting or rethinking the hypothesis"*. [9]

Regarding the interaction with computer games it has been pointed out by Jenson and de Castell that new types of input devices is increasingly making possible a particular type of learning related activity that should be distinguished from using simulations in general: imitation. While a simulation can use the pressing of various buttons as inputs, these buttons are conceptually unrelated to the actions they initiate. There is typically no morphological correspondence between the player's action of pressing a button and the resulting in-game action: *"There is of course an entirely arbitrary relation between the player's actions ('press A', for example and Mario's jumping). A button press is the technologically mediated means to the avatar's jumping, but it is of course nothing like the jumping. A button press bears no resemblance to a jumping event."*. [10]

Imitation, on the other hand, implies mimicking an action morphologically, requiring more sophisticated position/movement sensing input devices: *"In order to play, the player must imitate a golf swing, or a tennis swing, a baseball swing or even rolling a bowling ball with the controller. In effect, the player imitates the 'real world' action that is correlated with the action within the game."* [10]. Jenson and de Castell argues that the trend with increasingly sophisticated input devices constitutes a substantial epistemological shift, away from simulation of actions and instead enabling imitation in computer games arriving at a situation closer to that of traditional learning, where for instance young children imitate the behaviour of adults. [10]

Focusing not only on aspects of computer games alone, but broadening the picture to include the nature of today's learners as a result of their high exposure to, and natural relationship with computer games and computer mediated communication in general, further arguments for using games as learning tools have been

presented. Prensky argues that *"Today's students are no longer the people our educational system was designed to teach."* and remarks that *"Today's average college grads have spent less than 5,000 hours of their lives reading, but over 10,000 hours playing video games…".* [11] Coining the term *digital natives* for the generation having grown up with computer games and other recent information technology, Prensky outlines some of their typical characteristics: "*They like to parallel process and multi-task. They prefer their graphics before their text rather than the opposite. They prefer random access (like hypertext). They function best when networked".* [11]

In addition, Prensky links recent habits of playing computer games to research on neuroplasticity, summarising that *"… there is no longer any question that stimulation of various kinds actually changes brain structures and affects the way people think, and that these transformations go on throughout life."* [12]. Gaming habits come into focus regarding why behaviour-changing neuroplasticity has not been obvious in the past, where Prensky expands: *"A key finding of brain plasticity research is that brains do not reorganize casually, easily, or arbitrarily."* [12]. Instead, extensive practice is needed for neuroplastic changes to occur, and with the introduction of computer games into society, the type of repeated practice needed to induce such changes is now in place. As Prensky points out, in reference to a learning programme involving extensive practice: *"Several hours a day, five days a week, sharply focused attention – does that remind you of anything? Oh, yes – video games!"*. [12]

In the light of these aspects in combination with the previously mentioned key features of computer games, it becomes clear that games can fit very well as an educational tool. To exemplify we can consider the NASA massively multiplayer on-line learning game initiative launched by the Goddard Space Flight Center in an effort to increase learning in science, technology, engineering and mathematics, something which is important for NASA's human resources regrowth in the future. As detailed in the associated announcement for research document [13], this project is aimed at using computer games for learning purposes in the direct sense discussed so far: *"Virtual worlds with scientifically accurate simulations could permit learners to tinker with chemical reactions in living cells, practice operating and repairing expensive equipment, and experience microgravity, making it easier to grasp complex concepts and transfer this understanding quickly to practical problems"*. [13]

3 RESEARCH CRITICIZING COMPUTER GAMES IN LEARNING CONTEXTS

However, a number of disappointments regarding the direct approach, implemented in the form of specifically developed game based learning software sometimes referred to as edutainment or serious games, have been noted. Such edutainment is the result of efforts trying to explore the advantages of the game format and fill it with more traditional school curriculum oriented material. The usefulness of such edutainment software has been questioned in many cases, as observed by Kirriemuir: *"However, when game-oriented entertainment and learning or educational material are combined, the result has often been disappointing; the educational value is debatable or irrelevant, and the gaming and engagement qualities compare poorly to those of pure games"*. [14]

A similar standpoint is taken by Papert, viewing this edutainment offspring from games and education software as one possessing none of the best features from either parent: *"Shavian reversals – offspring that keep the bad features of each parent and lose the good ones – are visible in most software products that claim to come from a mating of education and entertainment"*. [7] More specifically, Kirriemuir and McFarlane identify several reasons for these shortcomings: *"Most edutainment has failed to realise expectations, either because:*

- *The games have been too simplistic in comparison to competing video games …*
- *The tasks are poorly designed and do not support progressive understanding …*
- *The target audience becomes aware that it is being coerced into 'learning', in possibly a patronising manner"*. [15]

In addition, it can also be noted that edutainment products that rely on the users first having familiarised themselves with instructions or introductions in order to play the game successfully, face the risk of being especially unsuccessful. This has been discussed by Jenson et al. after observing users of a computer game intended to aid learning about baroque music: *"In none of the play sessions did we observe anyone paying attention to or reading in any way instructions for the game…"*, and *"…they would not look to instructions even after failing and would instead seek out something more 'playable' … "*. [16]

Furthermore, even if an educational game is successful in the sense that it is engaging while also containing relevant material as discussed by Kirremuir, McFarlane and Papert above, an additional problem is described in [17]. Coining the term *Gamer Mode*, Frank observed students detaching themselves from the underlying domain that is in focus from a learning perspective, instead focusing partly or fully on the game itself, exploiting its functionality in order to win the game at any cost [17].

By distancing themselves from the subject to be studied, the learning occurring is that of mastering the game as such, and not the domain the game simulates. Such a situation constitutes a break from the effectiveness criterion as described by Hays who found that an instructional game *"will only be effective if it is designed to meet specific instructional objectives and used as it was intended."*. [18] Students going into gamer mode as described by Frank above, is an example of the game not being used as it was intended in Hays's sense.

The gamer mode phenomenon described by Frank above also highlights a difference regarding ambiguity between games for entertainment versus educational games. In an entertainment game, ambiguity resulting from unclear graphics or interface issues is less of a problem, as long as the player still can master the game through a gamer mode approach, learning how to play the game successfully without any deeper analysis of what concepts the ambiguous graphical element stands for. In an educational game however, the underlying domain that graphical elements represent is a main priority and must be clearly communicated through the game interface for the learning potential regarding this domain to remain.

In an effort to improve the quality of serious games Pereira and Roque have formulated a set of design guidelines, and in doing so addresses the issue of misconceptions that may arise in educational games due to possible ambiguity in the interpretation of the game interface: *"To prevent the player from building a mental model inconsistent with the game model, in a serious game all representations should have a clear and consistent purpose either in the interpretation of the game state or as an aesthetic contribution"* [19]. The underlying problem is illustrated by a student's misinterpretation of cars being shown adjacent to a village as an indicator of development: *"People don't want to go to the village, the cars get there and leave right away"* [19], further emphasizing that edutainment is not an unproblematic area.

Another potentially problematic aspect of particularly online games involving many participating players relates to the real-time nature of several simultaneous tasks necessary to handle. While the communication potential of such games is perceived positively by most, it is interesting that the parallel processing required is perceived as a problem by some. As pointed out by Juul [20], many games employ a 1:1 mapping between player time and event time. In multiplayer games, the event time is shared by participating players, so there is no way to go back in time by reloading a saved game state. The players thus need to simultaneously manage chatting and playing, with no possibility of redoing the exact same sequence of events. In a survey by Wiklund, most of the negative comments regarding communication issues related to the flow of game time: *"It can stop the game"* (boy, grade 4), *"When you miss something because you chatted. In games I mean"* (boy, grade 7), and *"That there is no time to play too"* (boy, grade 8). [21]

Finally, there is the critique formulated by Linderoth regarding certain types of games having a design that may give the illusion of learning rather than actual learning. While not rejecting the concept of learning games in general, Linderoth [22] describes cases where the underlying design of some games reward the

amount of time spent playing, rather than tasks hard to complete. This can be done explicitly, or implicitly by requiring the player to perform repetitive tasks, or rewarding him/her for doing so.

Such a game design may give a sense of achievement and progress even if only repetitive and non-challenging task are performed by the player: *"From the ecological perspective, observations of someone being able to play and progress in a game cannot be taken for granted as constituting the outcome of advanced learning processes. What we see might just as well be progression that is built into the game system, and a practice that, compared to other domains, requires very little learning from its practitioners."* and *"Games can give us the sensation of progress and empower us without demanding that we develop the kind of skills that many other domains require. Thus, perhaps some good video games offer a pleasure that comes from a continuous 'illusion of learning'."* [22]

4 POSSIBLE LONG-TERM LEARNING STIMULATING EFFECTS FROM COMPUTER GAME USE

On the other hand also an indirect, or meta level learning increasing effect from games is conceivable, by which none or very little actual learning takes place in the game, but instead the player is indirectly stimulated to undertake learning at a later time. This could be staged on a symbolic level in the game world, due to the way skills are typically represented in many computer games.

Using the NASA case as an example, with the direct game based learning approach first mentioned, there might be such things as quests failing if a player in orbit around a planet tried to travel much faster than another vehicle in the same orbit, as this would traverse him or her into another higher orbit, as illustrated in figure 1. Given that the player then realizes that two objects cannot travel with different speeds in the same orbit, learning will have occurred. Unfortunately, this approach may suffer from the drawbacks regarding edutainment, or serious games, described earlier.

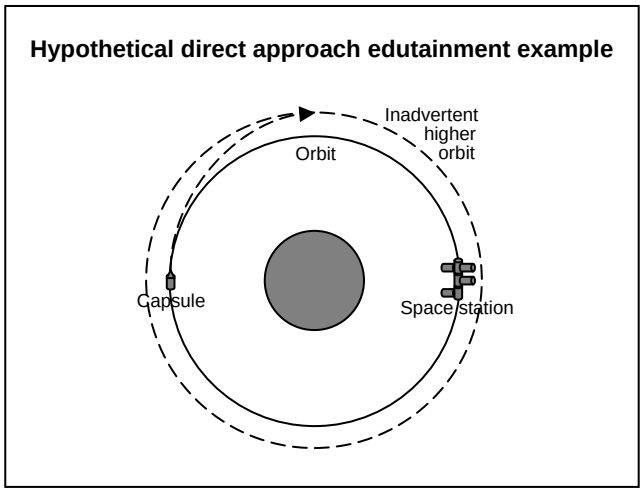

Figure 1. The catch up problem. Two objects cannot travel with different speeds in the same orbit without the presence of additional forces. A player in an orbiting capsule faced with the task to catch up with a space station will inadvertently end up in a higher orbit unless compensating measures are taken. The quest architecture directly involves learning issues relevant to the simulated domain.

With an indirect meta approach aiming at long-term effects regarding later learning however, there might instead be such things as labs with confused scientists and experiments having gone wrong. The related quests might have goals vaguely describing the need to help the scientists by locating missing equipment, symbolically turning knobs on the lab equipment, or even fight experimental robots wreaking havoc, without any actual knowledge being gained in this immediate process.

The acting mechanism with this meta approach would instead be the quest reward, typically consisting of increased skills in fields related to the type of lab, as indicated in figure 2. This could be indicated by an increasing numerical skill level value accessible through the game interface, as well as associated positive messages informing the player that he or she has gained skills in fields commonly associated with higher education studies.

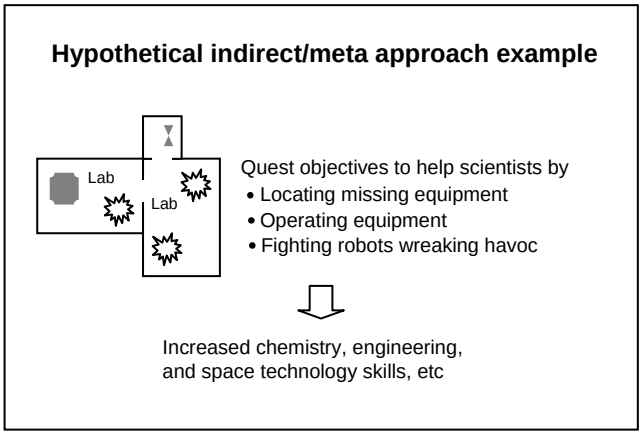

Figure 2. Quest architecture not directly involving learning issues relevant to the simulated domain. While no actual learning need to take place at game time other than purely operational skills in order to play the game, successful completion of quests lead to skill gains in fields commonly associated with higher education.

If the meta, or indirect learning approach game is then designed so that when a high enough skill level in say, space technology is achieved, then and only then can the player proceed (through space travel) to an amazing-looking space station on the surface of the moon, then the game has a potential to trigger an important psychological reward mechanism in the player's mind. Through the gradual fulfilment of the involved skill level requirements as indicated in figure 3, the causality of the perceived experience is ideally that with high enough skills, I could travel to the moon and beyond.

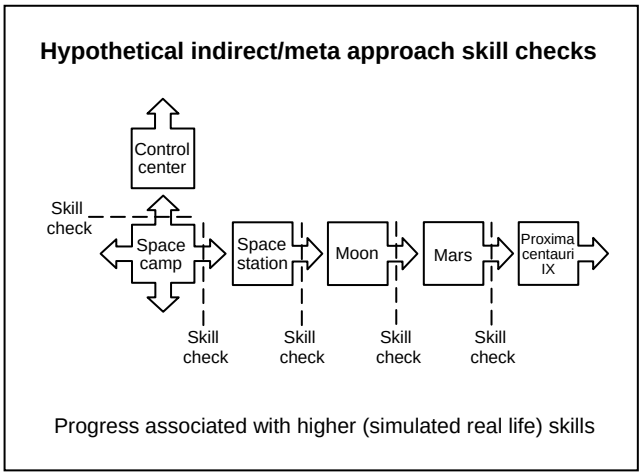

Figure 3. Skill checks applied before allowing advancement to higher game levels or desirable areas of the game associates the concept of possessing high skills with pleasant experiences. Using simulated real life skills such as electronics, physics or space technology in this context may indirectly influence the player when making later higher education choices.

With this approach it would not matter that the actual learning will have to take place elsewhere, and most likely later when the player makes decisions about his or her higher education. The important thing with this concept would rather be positive experiences associated with reaching in-game goals of high enough skills and the subsequent rewards of going into space and similar pleasant adventures. The meta level goals strived for by the game developer would be these positive feelings and their association with acquiring skills, residing in the player's mind, and remaining as (conscious or unconscious) memories long after the computer game has ended.

What would happen at game-time in a game with such a (hypothetically working) meta approach is not learning in the classical sense, but something perhaps even more interesting from a long term society perspective: the player's attitude towards learning may change in a positive direction. This would not be a learning game, but a learning stimulating game.

That this suggested learning stimulation effect may result from playing games not specifically designed for learning purposes is particularly interesting, as learning games and serious games have been criticised for lack of stimulation and that they sometimes tend to be too serious and not particularly engaging [23]. This also means that at least indirect learning effects may result from games closer to the Dutch historian and cultural theorist Johan Huizinga's definition of play. In his well-known book Homo Ludens, Huizinga claims that play should be seen as a non serious and free activity. [24]

How Huizinga's view of play should be interpreted and related to game based learning has been discussed and there is no clear consensus [25], [26]. Huizinga's description of Homo Ludens as a naturally playing man with play as a prime condition for the generation of culture could be traced back to the romantic idea of Friedrich Schiller on *play drive* (spieltrieb). Here man is found to be fully human only when he is playing. In his series of letters *On the Aesthetic Education of Man* [27] Schiller stated that:

"Man plays only when he is in the full sense of the word a human being, and he is only fully a human being when he plays."

Even if the essential ideas in Huizinga's book are on playing rather than on gaming [26] the book has brought in ideas in to modern game research in articles on playing everything from digital online multiplayer games like World of Warcraft [28] to more traditional multiplayer games like Football [29]. Play and logic are essentially different phenomena and there must also be a distinction between playing and gaming [26]. Games are defined by rules and with abstract challenges that result in quantifiable outcomes [30]. To insert educational content into various kinds of educational games is a strong trend that some researchers have described as a *mad rush* where sound educational principles and theories sometimes are absent [31].

This touches on the issue of whether playing and learning could be viewed as intertwined activities both contributing together to knowledge acquisition, or as a pair of separate activities where the former is limited to a being motivator for the latter. Restricting the role of the game playing component to a motivator for learning still means that considerable care has to be taken to implement the pair in a suitable way. As Sigurdardottir summarises: *"One of the fundamental discussions related to DGBL is the discussion about play on one hand and learning on the other. While most of the contributors to the debate argue that playing is a good motivator for learning, some have claimed play to be overestimated. Amongst those who do view play as a good motivating factor there is still a debate about whether or not it is adequately employed in educational games."* [32].

In a broad sense educational games might be defined as games that are designed to teach someone something and that almost any initiative that combines gaming and education can be considered as *game based learning* [33]. Serious games on the other hand should be designed for a distinct purpose and not for pure entertainment [30], and they have also been presented as:

> *" … a mental contest, played with a computer in accordance with specific rules, that uses entertainment to further government or corporate training, education, health, public policy, and strategic communication objectives."* [34]

In the widest sense, the suggested learning stimulating effects from COTS games discussed here could be included under the umbrella of game based learning. This could be the case even though the involved games are not actual learning games by design, a concept that also has support in the field of pedagogy. Especially in constructivism, the potential of combining games with learning has been discussed.

In older constructivism intelligence has been defined as the development of an assimilatory activity elaborated by the interaction between itself and the external environment [35]. With the existence of today's virtual game worlds, this external environment has grown larger, with increased possibilities of interaction through numerous varying game types. Sometimes, these game themes and environments are strongly aligned with the game type and it's associate functionality, while in other cases the underlying domain is merely a backdrop for quite contrasting game actions.

In a basic definition all games are built upon a set of defined rules dictating functionality, playing options and challenges. Rules, narration and reward structures can have large variations, with conflict and competition games differing from cooperation and collaboration games [30]. Narration and game themes are not always aligned and sometimes the game titles can be misleading. Gamers that expected *Halo Wars* and *Brutal Legend* to be about intense combat got disappointed when they found out that these games were of strategy type [36]. This is by far a new concept since even pure strategy games like chess originally are built on a symbolic warfare concept.

A recent example is *Spore*, a game with evolution as the main theme, although one criticism from subject matter experts has been that the connection to evolution is weak, and that the game's popularity seems to be based more on players' interest in creativity and fantasy rather than curiosity about biology [36]. On the other hand, a classic example of type and theme alignment is former president John F. Kennedy's favourite game Diplomacy, which might be seen as a learning game including diplomatic

negotiation techniques. Flight simulators and music games also have high type-theme cohesion, while purely abstract games like Tetris can be highly addictive even without any defined theme (ibid). In the light of this, the game type seems more important than the backstory, and learning games and serious games lacking playability are risking to be unplayed and seen as boring from a gamer's perspective [23].

There are still quite few educational games that enchant players, one possible reason being the relatively small development funding compared to standard budgets for mainstream entertainment games. The excitement over the actual game type is seen to be superior to content [36], however if a player spends hundreds of hours in a realistic space environment or a well-arranged historical setting it is hard to rule out theme related influence completely. Even without any game mechanisms at all a well-formed virtual environment like *Second Life* is claimed to stimulate curiosity, creativity and learning activities [37], [38], which can be seen as an example of constructivist ideas regarding interaction with one's environment in the learning process.

The meaning of interaction and playing games has been described by the Russian pedagogue Lev Vygotsky [39], another constructivist that find games to have a potential for training that might be applied in real world situations. He has also distinguished between a learner's actual development and the potential development that is possible only under guidance and collaboration.

A more radical constructivist view in which knowledge is only inter-subjectively or even only subjectively constructed seems harder to combine with curricula at university level, at least in natural and computer sciences. The Situated learning concept related to constructivism that has been described by Jean Lave and Etienne Wenger appears to be more applicable to modern adult learning. This is a type of learning where individuals are supposed to construct knowledge by socialisation, visualisation, and problem solving [40]. However, it is not possible to find any guidelines in constructivism covering how games should be designed more in detail to be engaging and to support learning at the same time. On the other hand, as some researchers have pointed out in the exploration of game design for the modern Homo Ludens generation, it is likely the case that: *"pleasure comes before performance and engagement before clarity"* [41].

As the potential learning stimulating effect of playing games discussed in this paper is separate in time from future learning environments, this particular aspect of games and learning does not suffer from some problems otherwise arising when combining these areas. To illustrate this, Heidegger's concept of *breakdown* and the related terms *ready-to-hand* and *present-at-hand* [42] may be in conflict with the concept of *flow* [43], [44]. As discussed in [45] breakdown may be beneficial from a learning perspective, while on the other hand it may be a desirable game design goal to keep the player in a highly enjoyable mental state of uninterrupted flow as much as possible [46]. These mechanisms are not in conflict with each other if not occurring in the same context.

It is interesting that in the critique put forward by Linderoth that some game designs may give the illusion of learning rather than actual learning, one possible positive effects of such an illusion is touched upon: *"Since one of the reasons why players might feel motivated could be that games give us a feeling of having achieved more than we have, this design pattern gives us an illusion of learning. An experience of becoming better and progressing towards a goal without having to develop skill might not be something that educational institutions benefit from. Maybe it can be used in order to enhance self-esteem for low achieving students where the illusion of progression can be something positive and have an effect on real performance."* [47].

The view suggested in this paper is both in line and at the same time not in line with Linderoth's comment above, when we expand the learning illusion effect to a wider scenario. While agreeing that illusion of progression may have an effect on learning performance where enhancing self esteem is an issue, we argue that educational institutions may also benefit from the illusion of learning in a wider sense. When seen in a long-term societal context, memories of previous in-game success enabled by illusorically achieving skills may be a factor when decisions to apply for higher education are made.

This possible long-term effect of games portraying skill increases in areas associated with higher education is something that goes beyond the debate on pros and cons of learning games. Learning stimulating games can be seen as a "third thing" in game based learning, with indirect acting mechanisms which may affect what later learning is undertaken.

5 FUTURE RESEARCH

To further investigate the learning stimulation effects discussed here, a long term as well as large scale study is needed. Initially, key variables might be level of higher education in relation to previous gaming experience. This first step could be carried out through a survey focusing on quantitative data from respondents constituting a societal cross-section of a specific age group.

Comparing average prior gaming activity among university students with that of other groups may show a distinct pattern, but is in itself only a first step towards a deeper understanding. To get a deeper understanding of the topic, the quantitative study may be complemented with an in-depth qualitative study based on interviews. Through this combination of data sources, issues regarding causality can be discussed such as the possible learning stimulating effects suggested in this paper.

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