

Physically Active Games for the Cognitive Activation of Students

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Abstract—The article describes an implementation of the idea to cognitively activate students in the break of a demanding university class by brief, moderate intensity physical activity. The article's primary contribution is a categorized list of suitable games. The article is based on the author's participant-observations of activity breaks in an introductory programming course for game designers. The data have been collected in seven iterations of the course over six years. Most of the games selected and facilitated by the students in the activity break are well-known and only mildly competitive children's games. The most popular games are reaction games; followed by running/tagging and throwing/hitting games. Games are regularly modified if they do not feature enough movement or opportunity for the participation of enough players.

Keywords—games, physical activity, cognitive processes, learning

I. INTRODUCTION

The article reports experiences with implementing the idea to cognitively activate university students (and the teacher(s)) in the break of a demanding university class by brief, acute bouts of physical activity (PA) of moderate intensity. The physical exercise is facilitated by games. The activity is clearly separated from and does not overlap with the educational course content, and participation by students is voluntary. The intervention is intended to produce immediate and short-term benefits for learning.

PA is generally believed to benefit cognitive processes [8]. Singh et al. (ibid.) report that of the 'reviews and reports [...] published during the last decade' the majority finds 'that PA is positively associated with cognition and with structural and functional brain health and a neutral association with academic performance for children'. Reference [1] finds that 'acute exercise' benefits adult's 'cognitive function[s]' such as attention when it 'act[s] in a way similar to psychostimulant drugs'. This observation is shared by [2] who in their meta-study report that 'both regular and irregular' exercise 'leads to an increase in the level of oxyhemoglobin, facilitating the operation of executive functions for up to 30 min'.

On the connection of learning and PA, [3] note, that '[p]hysical activity increases production of neurotransmitters that support learning readiness; oxygen flow, which facilitates healthy brain functioning, and the brain chemical BDNF, which enhances creation of neurons and synapses'; they observe that 'active play and regular exercise' positively effect 'brain regions associated with executive function, learning, and memory, thus increasing student achievement'. Several studies 'report an association between physical activity and better grades at school' [2]. Many other report similar results on the connection of physical activity and beneficial cognitive effects (see, for instance, [4], [5], [6], [8]).

This article describes the actual implementation of an activity break in a course taught by the author over several years, and lists and categorizes games that were proposed and facilitated by the students and played during a class break. The article's main contribution is the collection of the games.

II. SETUP

Activity breaks are implemented in a first year Master introductory programming course for game designers at a small European university which specializes in IT-related programmes. The majority of students come from the games programme, but the course attracts a fair number of students from other programmes. The course became mandatory for game design students in 2017 and moved from the Autumn to the Spring semester; interestingly, the number of games students in the course stayed roughly the same, but the number of students from other programmes and other universities increased considerably from that point (from just over 11% average to almost 40%; total number of course participants rose from about 20 to 40). The course is organized in the university's default pattern, that is, one 4h slot per week divided into 2h lecture and 2h exercise, in a 14 weeks semester. The course is taught by the author as the only teacher or as the main teacher together with one external lecturer, and with one or two Teaching Assistants (TAs). The data were collected in seven iterations of the course between Spring 2014 and Autumn 2019.

In-line with published research, the *Action Break* is expected by this author to have several beneficial effects on students' course learning: An increased reflective distance by students changing their mindsets from and back to the educational activity, and a renewed ability to focus and exert attention. Also, the intervention should activate students from listening to acting. The intervention is also expected to have social effects such as an increased perceived approachability of the teacher(s) (who participate(s) in the activities) during and after the intervention.

In the first lecture of the semester, the activity breaks are introduced to the students as *Action Breaks*, and the reasoning behind the idea is explained verbally and in writing:

'The Action Break has been invented for a specific reason: One can't learn programming for four hours straight. [...] Everybody please participate in the break activities. Not to waste time that could and should be used for learning, but on the contrary, to be able to continue learning, get some distance, to take a fresh look afterwards, to learn more and faster, in effect.' (Course materials, Autumn 2020)

The first *Action Break* (table football) is selected by the (main) teacher and facilitated by the TA(s). The winning

team is then tasked to select and facilitate a game for the *Action Break* in the following week. The game has to meet four requirements:

- 'Be outside our [classroom];
- Feature lots of movement – the more the better;
- Have a winning team; and
- Be fun.' (Ibid.)

The games also have to be suited for all (attending) course participants to play together; every game can only be chosen once per semester; and the *Action Break* should take only twenty minutes (nominally; factually there is a downtime of about 30 minutes before teaching resumes). Any equipment the *Action Break* requires has to be sourced by the facilitating students. Participation is voluntary, and students are neither given course credit for facilitating nor for participating in *Action Breaks*.¹

While there exist only 'too few studies [which] use any particular type of intervention' to comment on the effectiveness of specific types of interventions [2], in one of the few studies on the cognitive effects of a specific PA, [7] report that 'a short cognitively engaging [physical] activity' has most positive impact on 'children's attention at school'. Reference [1] finds that 'sports and games that require high coordination skills, as well as cognitive action to guide strategy during play, may be especially valuable for brain development. [...] the wide variety of motor patterns and continual tactical adjustments needed in most sports and games may activate more regions of the brain than aerobic activities that are motorically less complicated and less varied.' The *Action Break* thus employs games to facilitate high intensity PA, because games are usually a more cognitively demanding activity than, for example, fitness exercise; secondary reasons are that the course is located within a games programme, and that games appear to be more motivating to many people to engage in than pure exercise.

The course starts at 12h, has a 20–30 minutes lunch break around 13h, and the *Action Break* around 14.30h. That means that the *Action Break* is usually done between the lecture and the exercise (at the beginning of the semester, when there are longer lectures), or during the exercise (later in the semester, when most of the teaching time is spent in a workshop format). In the exercise after the lecture, participants take breaks on their own. The course officially ends at 16h, but often extends by some minutes up to an hour.

In the period of the study, all proposed games for *Action Breaks* have been played; not a single game has ever been rejected because it did not meet the requirements². The course is taught in classrooms, which varied over the years. The *Action Break* always happens outside the classroom³; but the various locations of the different rooms in the university building make different outside locations more accessible

than others. The *Action Breaks* have taken place in the university's central (indoor) atrium on the ground floor, in the university's basement, outside the building in the field next to the parking lot, outside the building next to one of the main entrances, and even in the small space on the corridor in front of the classroom. About half of all *Action Breaks* happen in the atrium, which is large and reasonably accessible from all classrooms in the building. Most of the students attending class also participate in the *Action Break*, as do all TAs and teachers; in the author's estimate, participation ranges from less than ten to more than 30 participants.

The *Action Breaks* rely on students to facilitate them week to week. Often, at least one or two students of a winning team are present to facilitate the *Action Break* in the following week; but occasionally none is, then the *Action Break* is postponed to the following week. If this happens early in the semester, the teacher usually asks the (attending) students (or the TA(s)) if they know a game they can facilitate. If students stop facilitating the *Action Break* late in the semester, nothing is done. On average, there are eight or nine *Action Breaks* per semester (Fig. 1), most of them in the first part of the semester (Fig. 2). There never is an *Action Break* in week 8 because the course always has a mandatory hand-in in week 8 and no class.

Usually, the teacher asks at the beginning of class if the student team who is to facilitate the *Action Break* is present and aware; occasionally, games are then created or found between that point in time and when the *Action Break* happens a few hours later.

III. THE GAMES

Four categories based on the activities performed by the players are here proposed to categorize the games (Table 1)⁴. Borderline cases were placed in the category estimated by the author to be dominant⁵. A low number of games were not categorized because they turned out not to match the requirements for the *Action Break* (such as featuring lots of movement, see above), or the available information on rules were incomplete or inconclusive.

There are a total of 61 instances of *Action Breaks* in seven iterations of the course, with 47 different (categorized) games facilitated⁶. When using the categories proposed here, the most popular games are reaction games (ten games played in 19 instances); less and almost equally popular are running/tagging games (nine games played in ten instances) and throwing/hitting games (seven games played in ten instances (excluding table football)); the least popular category is balance games (seven games and instances). There are seven games in the other/uncategorized category which either do not involve a meaningful amount of movement (such as a spelling game and *Human Battleship*) or could not be identified (anymore), and are likely informal

1 While the students are asked to participate in the *Action Break*, participation is not mandatory. The mandatory elements of the course are unambiguously stated in the online and offline course materials and verbalized in class.

2 *Musical Chairs* is blacklisted up front after many years, because it regularly came up as one of the first games proposed, students were very familiar with it, and it was perceived as a boring and uninspired default selection. Some games feature considerably less movement than others, for instance, Building paper airplanes, *J'Accuse* and *Human Battleship*.

3 Photos show that three out of eight *Action Breaks* have been facilitated inside the classroom in the first iteration of the course in 2014. The requirement that *Action Breaks* are to be done outside of the classroom was introduced for the next iteration of the course in 2015.

4 The focus on the activities specifically means that the numerous games which incorporate relay mechanisms are not placed in a single category; it appears that in many *Action Breaks*, various games, which are not specifically physically demanding or cannot accommodate a large number of players, are simply combined with a relay part to match the requirements.

5 A game such as Handkerchief tag, in which the surprise moment is emphasized over the running and catching part is thus placed in the reaction/luck category; Freeze TagIT and Vote Tag are taken to be essentially tagging games; Building paper airplanes contains the essential competitive element of throwing them, so the game is placed in the 'throwing' category, while Building garlands lacks this element, and is thus placed in the 'other' category.

6 Including table football.

children's games, local versions of well-known games under a different name, or custom-made games.

A typical game in the run/catch/tag category is *Snake* (tag), in which one person starts to tag people; when somebody is tagged, he/she joins hands with the person who tagged him/her, and they together continue to try to catch people. Table tennis is a typical game from the throw/hit category; it was played in the *Action Break* in the around-the-world variant, in which multiple players participate in one game of table tennis, and everyone in turn hits the ball. A typical reaction game is *Musical Chairs*. Chicken fight is a

balance game in which players try to push over other players while standing or jumping on one leg only. In the 'Other' category are DeKoven's *J'Accuse* and *Human Battleship*; intense movement is not an essential part of either game⁷; Building garlands is a construction competition, in which the movement part is hanging up the garlands.

⁷ In *J'Accuse*, players are walking around and shaking hands to camouflage the killer handshake, and the enactment of being killed is for dramatic effect only. In *Human Battleship*, people mark the positions of the ships on the grids with their bodies, and may move for dramatic effect when ships sink.

TABLE 1. CATEGORIZED LIST OF GAMES WITH NUMBER OF INSTANCES PLAYED^a

Run/catch/tag/pull	Throw/hit	Reaction/luck	Balance ^b	Other and uncategorized
<i>Snake</i> /Chain gang tag (2)	Table football (7)	<i>Musical Chairs</i> (variants, such as Fruit Salad) (6)	Spoon Relay	<i>J'Accuse</i>
Knot	Make things go far/ Building paper airplanes (3)	Red light green light/Fisherman's questions (2)	Climbing over people	<i>Human Battleship</i>
Tug of war	Table tennis (2)	Ninja/Samurai (3)	Don't touch the floor	Building garlands
Rock tag	Dodge ball	Balloon stomp fight	Human knot	Chain message
Rowing relay	Nation ball	Who wears black underwear	Chicken fight	Bok Bok Fox
Hide and seek	Coin roll	Dib dip dibbi dip	String-pen-bottle game	Spelling game
Ultimate sponge	Balloon-bottle team match	Relay Tictactoe	Paper relay	Human audio memory
Stop there/Freeze TagIT (2)	Paper ball kicking	Handkerchief tag		
Vote tag		Start-stop movement game		
		Danish clapping game/Zip Zap Zop (2)		

^a Essentially identical games with different names are combined into one entry. Game names and titles are translated into English by the author.

^b Games in which players balance themselves (Don't touch the floor) or an item (Paper relay)

The list of games played shows that the majority of games are well-known children's games (such as *Snake*/Chain tag, hide and seek, dodge ball, Nation ball, *Musical Chairs*, Red light green light/Fisherman's questions, Stop there, Who wears black underwear, Balloon stomp fight, Don't touch the floor). One game is a children's game (Chain gang tag) fitted with the name of a classic digital game (*Snake*). Three games are construction competition games (Building paper airplanes). Two games play with social conventions (Fisherman's questions/Who wears black underwear). One collaborative game (Human knot) is played in (two) teams to make it competitive. There is only one sports game (table tennis, played twice)⁸, and only one game which relies purely on bodily strength (tug of war). Pure chance-based games are fully absent (there is one instance of the chance-based rock-paper-scissors mechanism, which is combined with a tagging game). There are several games which could not be identified, and it is possible that they are games custom-made specifically for the occasion (such as Tile jumping, which is a *Musical Chairs* variant).

The most popular games facilitated in *Action Breaks* are reaction games (Table 1). While the in-game skills players command are likely to vary widely, reaction games enable players of various skill levels to play together, possibly more so than games that rely on skills such as throwing or hitting items.

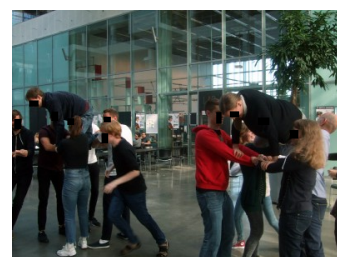


Figure 1. Participants climbing over each other's arms in *Climbing over people*

In the author's recollection, several games stand out for various reasons: Climbing over people (Figure 1), Human knot and Don't touch the floor with the most physical contact; tug of war with high engagement and test of pure bodily strength; Who wears black underwear with the most

⁸ Table football is not counted because it is selected by the teacher.

borderline socially acceptable questions (similar to *Truth or Dare*); and table football with brief (60 seconds) and intense matches. Most liked seem to be games where many players can (inter-) act at once and intensely with each other, possibly featuring close proximity between players.



Figure 2. *Fruit Salad*, a *Musical Chairs* variant

Many games have been facilitated in the *Action Breaks* by student teams, but enthusiasm varied. Games have been invented, found and adapted. Occasionally, some default games are proposed, such as *Musical Chairs*. In Spring 2016, in week two, Tile jumping was played which is a custom-made *Musical Chairs* variant, then in week four, *Fruit Salad* was played (Figure 2), which is another *Musical Chairs* knockoff, and then two weeks later, *Musical Chairs*. In the Spring 2015 course *Stop there and Freeze TagIT*, which are essentially the same games, were played in weeks four and five. In the Spring 2017 course, there were two (different) games with air balloons facilitated right after each other (weeks nine and 13, with no other *Action Breaks* in-between), because, the facilitating students said, they had to use up the balloons they had acquired for the first game.

The selection of games is influenced by many factors, such as personal knowledge and experience with games, and previously facilitated games. Various kinds of games are also popular in different courses; for instance, advancing games (such as Red light green light) in Spring 2017, chaotic collaborative games (such as Climbing over people and Human knot) in Autumn 2017. Another factor certainly is the available locations. Although several locations are in principle and factually available, once the tradition of having the *Action Break* in the atrium is established, it is rarely challenged. The atrium is large and high, with a concrete floor. It contains furniture (such as tables, chairs, sofas, plants), staircases and the university's reception booth. It is framed by glass walls; many doors lead to the outside and to various rooms. Depending on the time of day, many people traverse the atrium. The atrium is also very visible from several floors of balconies and meeting rooms.

Many players appear not to be overly competitive in *Action Breaks*. Many of the (e.g. children's) games also have too loose or unbalanced rules for proper competition (e.g. floor is lava); often, the location or equipment is simply not suited to competitive play (e.g. using books instead of bats in table tennis); the skills of players vary widely in some of the games, so there is little point in going all out (e.g. in table football). A few of the games are simply too random to be competitive (Human knot). It is also possible that some players only want to 'lose early' as one participant notes in his/her feedback (2019, see below); this applies only to games where players drop out when they lose. In the cases where games are not sufficiently competitive to produce a winning team, a competitive angle is introduced (e.g. Building garlands).

Not all games are team games. Some games which are individual competitive games (such as *Snake/Chain gang tag*)

assemble the winning team required for *Action Breaks* in several rounds or stop when a suitable number of players are left.

IV. CONCLUSION

The article described an implementation of the idea to cognitively activate students in the break of a demanding university class by brief, moderate intensity physical activity. The article described the actual implementation of an activity break in a course taught by the author over several years, and listed and categorized games proposed and facilitated by the students. The article's main contribution was the collection of the games.

It was found that most of the games selected and facilitated by the students in the activity break were well-known and only mildly competitive children's games. The most popular games were reaction games; less popular were running/tagging and throwing/hitting games. There were a few instances of construction games, and games that play with social conventions. Sports games and purely physical strength-based competitions were rarely facilitated. Games were regularly modified (for instance, fitted with a relay part) if the games did not feature enough movement or opportunity for the participation of a sufficient number of players.

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